# Table of Contents

## TECHNICAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>Division</th>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>03</strong></td>
<td>032000</td>
<td>Concrete Reinforcement</td>
</tr>
<tr>
<td></td>
<td>033000</td>
<td>Cast-In-Place Concrete</td>
</tr>
<tr>
<td></td>
<td>033600</td>
<td>Special Concrete Floor Finishes</td>
</tr>
<tr>
<td></td>
<td>034100</td>
<td>Precast Concrete</td>
</tr>
<tr>
<td><strong>04</strong></td>
<td>042200</td>
<td>Concrete Masonry Unit</td>
</tr>
<tr>
<td></td>
<td>045100</td>
<td>Flue Liner Masonry</td>
</tr>
<tr>
<td></td>
<td>045400</td>
<td>Fire Brick</td>
</tr>
<tr>
<td><strong>05</strong></td>
<td>051200</td>
<td>Structural Steel</td>
</tr>
<tr>
<td></td>
<td>053110</td>
<td>Steel Roof Deck</td>
</tr>
<tr>
<td></td>
<td>054000</td>
<td>Cold-Formed Metal Framing</td>
</tr>
<tr>
<td></td>
<td>055000</td>
<td>Miscellaneous Metal</td>
</tr>
<tr>
<td></td>
<td>055013</td>
<td>Metal Fabrications</td>
</tr>
<tr>
<td></td>
<td>055200</td>
<td>Metal Railings</td>
</tr>
<tr>
<td></td>
<td>055213</td>
<td>Pipe and Tube Railings</td>
</tr>
<tr>
<td></td>
<td>057500</td>
<td>Decorative Formed Metal</td>
</tr>
<tr>
<td></td>
<td>057510</td>
<td>Ornamental Metals</td>
</tr>
<tr>
<td><strong>06</strong></td>
<td>061000</td>
<td>Rough Carpentry</td>
</tr>
<tr>
<td></td>
<td>061050</td>
<td>Miscellaneous Carpentry</td>
</tr>
<tr>
<td></td>
<td>061600</td>
<td>Sheathing</td>
</tr>
<tr>
<td></td>
<td>062210</td>
<td>Wood Trim and Accessories</td>
</tr>
</tbody>
</table>
# TABLE OF CONTENTS

## DIVISION 07 - THERMAL AND MOISTURE PROTECTION
- 072100 - Thermal Insulation
- 072726 - Fluid-Applied Vapor-Permeable Membrane Air Barrier (VPAB)
- 074100 - Insulated Metal Roof Panels
- 074113.16 - Standing-Seam Metal Roof Panels
- 074293 - Soffit Panels
- 074616 - Aluminum Siding
- 075423 - Thermoplastic Polyolefin (TPO) Roofing
- 076200 - Sheet Metal Flashing and Trim
- 077100 - Roof Specialties
- 079200 - Joint Sealants

## DIVISION 08 - OPENINGS
- 081113 - Hollow Metal Doors and Frames
- 081613 - Fiberglass Reinforced Plastic Doors
- 082120 - Stile and Rail Wood Doors
- 083213 - Sliding Aluminum Framed Glass Doors
- 083313 - Coiling Counter Doors
- 084110 - Aluminum-Framed Entrances and Curtainwall
- 087100 - Door Hardware
- 088000 - Glazing
- 088100 - Spandrel Glass

## DIVISION 09 - FINISHES
- 092600 - Gypsum Board Assemblies
- 093013 - Ceramic Tiling
- 095100 - Acoustical Panel Ceiling
- 096513 - Resilient Bases
- 096700 - Resinous Flooring
- 099000 - Paints and Coatings

## DIVISION 10 - SPECIALTIES
- 101419 - Dimensional Letter and Symbol Signage
- 101423 - Panel Signage
- 102113.19 - Plastic Toilet Compartments
- 105200 - Fire Protection Specialties
- 108010 - Toilet and Bath Accessories

## DIVISION 12 - FURNISHINGS
- 122513 - Motorized Roller Shades
- 123661.19 - Quartz Agglomerate Countertops
- 124800 - Playground Equipment and Structures
- 129300 - Site Furnishings
# Table of Contents

## Division 22 - Plumbing
- 221000 - Plumbing Piping Systems
- 221031 - Plumbing Piping Valves and Accessories
- 221113 - Facility Water Distribution Piping
- 221313 - Facility Sanitary Sewers
- 221319.13 - Sanitary Drains
- 221333 - Package Lift Station
- 223437 - Domestic Water Heaters
- 224000 - Plumbing Fixtures and Trim

## Division 23 - Heating, Ventilating, and Air Conditioning (HVAC)
- 230000 - Basic Mechanical Requirements
- 230410 - Electronic Variable Speed Drives
- 230513 - Motors
- 230529 - Sleeves Flashings Supports and Anchors
- 230548 - Vibration Isolation
- 230553 - Mechanical Identification
- 230700 - System Insulation
- 230719 - Piping Insulation
- 232000 - HVAC Piping Systems
- 233113 - Ductwork
- 233114 - Ductwork Accessories
- 233713 - Air Distribution Devices
- 234000 - Filters and Accessories
- 236213 - Air-Cooled Split-System Air Conditioning Units
- 238220 - Fans, Intakes and Relief Vents
- 238233 - Electric Duct Heaters

## Division 26 - Electrical
- 260001 - Electrical General Provisions
- 260125 - Electrical Testing
- 260501 - Electrical Basic Materials and Methods
- 260519 - Low Voltage Conductors and Cables
- 260526 - Grounding and Bonding for Electrical Systems
- 260533 - Electrical Raceways
- 260534 - Electrical Boxes
- 260553 - Identification for Electrical Systems
- 260573 - Short Circuit Analysis-Coordination Study
- 260926 - Low Voltage Lighting Control
- 262200 - Low Voltage Transformers
- 262416 - Panelboards
- 262701 - Electrical Service Entrance
### TABLE OF CONTENTS

100% Construction Documents – 03-15-2019

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>262717</td>
<td>Equipment Wiring</td>
</tr>
<tr>
<td>262726</td>
<td>Wiring Devices</td>
</tr>
<tr>
<td>262817</td>
<td>Enclosed Circuit Breakers</td>
</tr>
<tr>
<td>262818</td>
<td>Enclosed Switches</td>
</tr>
<tr>
<td>264313</td>
<td>Surge Protective Devices (SPDs)</td>
</tr>
<tr>
<td>265100</td>
<td>Interior Lighting</td>
</tr>
<tr>
<td>265600</td>
<td>Exterior Lighting</td>
</tr>
</tbody>
</table>

#### DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

- 283100 - Fire Detection and Alarm

#### DIVISION 31 - EARTHWORK

- 311000 - Site Clearing
- 312000 - Earth Moving
- 312319 - Dewatering
- 313116 - Termite Control
- 315000 - Excavation Support and Protection
- 316000 - Riprap

#### DIVISION 32 - EXTERIOR IMPROVEMENTS

- 321123 - Aggregate Base Course
- 321216 - Asphalt Paving
- 321313 - Concrete Paving
- 321713 - Parking Bumpers
- 321723 - Pavement Markings
- 322000 - Concrete Unit Pavers
- 323120 - Ornamental Steel Fences and Gates
- 323200 - Wire Mesh Gabions
- 323300 - Coir Logs
- 329000 - Trees, Shrubs and Groundcovers
- 329213 - Hydromulching
- 329219 - Hydraulic Seeding

#### DIVISION 33 - UTILITIES

- 330500 - Common Work Results for Utilities
- 330510 - Dechlorination Activities
- 334100 - Storm Utility Drainage Piping
- 334105 - High Density Polyethylene (HDPE) Pipe and Fittings

END OF TABLE OF CONTENTS
1.1 DESIGN PROFESSIONALS OF RECORD

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Section 017300 - Execution
Section 033600 – Special Concrete Floor Finishes
Section 045100 - Flue Liner Masonry
Section 045400 - Fire Brick
Section 054000 - Cold-Formed Metal Framing
Section 055013 - Metal Fabrications
Section 055200 - Metal Railings
Section 055213 - Pipe and Tube Railings
Section 057500 - Decorative Formed Metal
Section 057510 - Ornamental Metals
All of Division 06 - Wood, Plastics and Composite Sections
All of Division 07 – Thermal and Moisture Protection Sections
All of Division 08 – Openings Sections
All of Division 09 – Finishes Sections
All of Division 10 – Specialties Sections
Section 122513 – Motorized Roller Shades
Section 123661.19 - Quartz Agglomerate Countertops
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- Section 033000 - Cast-In-Place Concrete
- Section 042200 - Concrete Masonry Unit
- Section 051200 - Structural Steel
- Section 053110 - Steel Roof Deck
- Section 055000 – Miscellaneous Metal

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- Section 034100 – Precast Concrete
- Section 221113 – Facility Water Distribution Piping
- Section 221313 – Facility Sanitary Sewers
- Section 221333 – Package Lift Station
- Section 311000 – Site Clearing
- Section 312000 – Earth Moving
- Section 312319 – Dewatering
- Section 313116 - Termite Control
- Section 316000 - Riprap
- Section 321123 – Aggregate Base Course
- Section 321216 – Asphalt Paving
- Section 321313 – Concrete Paving
- Section 321713 - Parking Bumpers
- Section 321723 - Pavement Markings
- Section 322000 - Concrete Unit Pavers
- Section 321723 – Pavement Marking and Markers
- Section 323120 - Ornamental Steel Fences and Gates
- Section 323200 – Wire Mesh Gabions
Section 323300 – Coir Logs
Section 330500 – Common Work Results for Utilities
Section 330510 – Dechlorination Activities
Section 334100 - Storm Utility Drainage Piping
Section 334105 – High Density Polyethylene (HDPE) Pipe and Fittings

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Section 015639 – Temporary Tree and Plant Protection
Section 124800 – Playground Equipment and Structures
Section 129300 – Site Furnishings
Section 329000 – Trees, Shrubs and Groundcovers
Section 329213 - Hydromulching
Section 329219 – Hydraulic Seeding
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Section 221000 - Plumbing Piping Systems
Section 221031 - Plumbing Pipes, Valves and Accessories
Section 221319.13 – Sanitary Drains
Section 223437 - Domestic Water Heaters
Section 224000 - Plumbing Fixtures & Trim
Section 230000 - Basic Mechanical Requirements
Section 230410 – Electronic Variable Speed Drives
Section 230513 - Motors
Section 230529 - Sleeves, Flashings, Supports and Anchors
Section 230548 - Vibration Isolation
Section 230553 - Mechanical Identification
Section 230700 – System Insulation
Section 230719 - Piping Insulation
Section 232000 - HVAC Piping Systems
Section 233113 – Ductwork
Section 233114 - Ductwork Accessories
Section 233713 - Air Distribution Devices
Section 234000 – Filters and Accessories
Section 236213 -Air-Cooled Split-System Air Conditioning Units
Section 238220 – Fans, Intakes and Relief Vents
Section 238233 – Electric Duct Heaters
Section 260001 - Electrical General Provisions
Section 260125 – Electrical Testing
Section 260501 - Basic Materials and Methods
Section 260519 – Low Voltage Conductors and Cables
Section 260526 – Grounding and Bonding for Electrical Systems
Section 260533 – Electrical Raceways
Section 260534 - Electrical Boxes
Section 260553 – Identification for Electrical Systems
Section 260573 - Short Circuit Analysis - Coordination Study
Section 260926 – Low Voltage Lighting Control
Section 262200 - Low Voltage Transformers
Section 262416 – Panelboards
Section 262701 – Electrical Service Entrance
Section 262717 – Equipment Wiring
Section 262726 – Wiring Devices
Section 262817 – Enclosed Circuit Breakers
Section 262818 – Enclosed Switches
Section 264313 – Surge Suppression Device (SPDs)
Section 265100 – Interior Lighting
Section 265600 – Exterior Lighting
Section 283100 – Fire Detection and Alarm
SECTION 013233
PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for the following:
   1. Preconstruction video recordings.

1.2 INFORMATIONAL SUBMITTALS

A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each video recording. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.

B. Video Recordings: Submit video recordings within three days of recording.
   1. Submit video recordings by posting to Project Web site.
      a. Provide video recording of pre-construction activities
      b. Provide video recording of periodic construction events, including phase completion.

   2. Identification: With each submittal, provide the following information:
      a. Name of Project.
      b. Name of ODR and Construction Manager.
      c. Name of Contractor.
      d. Date video recording was recorded.
      e. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
      f. Weather conditions at time of recording.

1.3 USAGE RIGHTS

A. Obtain and transfer copyright usage rights from photographer to Owner for unlimited reproduction of photographic documentation.
PART 2 - PRODUCTS

2.1 PHOTOGRAPHIC MEDIA

A. Digital Video Recordings: Provide high-resolution, digital video on storage media and in format acceptable to ODR.

PART 3 - EXECUTION

3.1 CONSTRUCTION VIDEO RECORDINGS

A. Recording: Mount camera on tripod before starting recording unless otherwise necessary to show area of construction. Display continuous running time and date. At start of each video recording, record weather conditions from local newspaper or television and the actual temperature reading at Project site.

B. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed, recent events, and planned activities. At each change in location, describe vantage point, location, direction (by compass point), and elevation or story of construction.

   1. Confirm date and time at beginning and end of recording.
   2. Begin each video recording with name of Project, Contractor's name, videographer's name, and Project location.

C. Preconstruction Video Recording: Before starting construction, record video recording of Project site and surrounding properties from different vantage points, as directed by ODR and Construction Manager.

   1. Flag construction limits before recording construction video recordings.
   2. Show existing conditions adjacent to Project site before starting the Work.
   3. Show existing buildings either on or adjoining Project site to accurately record physical conditions at the start of construction.
   4. Show protection efforts by Contractor.

END OF SECTION 013233
SECTION 015639
TEMPORARY TREE AND PLANT PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes the protection and trimming of trees that interfere with, or are affected by, execution of the Work, whether temporary or new construction.

B. Related Sections include the following:

1. Earth Moving Section 312000
2. Excavation Support and Protection Section 315000
3. Hydromulching Section 329213
4. Hydraulic Seeding Section 329219

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Qualification Data: For firms and persons specified in “Quality Assurance” Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and Owners, and other information specified.
C. Certification: From a qualified Arborist that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.
D. Tree Protection Plan: Contractor shall submit a tree protection plan showing limits of chain link and vinyl fence prior to commencement of construction.

1.4 QUALITY ASSURANCE
A. Tree Service Qualifications: An experienced tree service firm that has successfully completed tree protection and trimming work similar to that required for this Project.
B. Arborist Qualifications: An Arborist certified by the International Society of Arboriculture or licensed in the jurisdiction where project is located is required to perform any pruning of existing trees to remain.

C. Tree Pruning Standards: Comply with ANSI A300, “Trees, Shrubs, and Other Woody Plant Maintenance—Standard Practices,” unless more stringent requirements are indicated.

D. Pre-installation Meeting: Tree protection and tree trimming will be an agenda topic at the Pre-installation Meeting. All tree trimming to be coordinated with Owner including the Natural Resource coordinator.
   
   1. Before starting tree protection and trimming, meet with representatives of authorities having jurisdiction, Owner, consultants, and other concerned entities. Review tree protection and trimming procedures and responsibilities. Notify participants at least ten (10) working days before convening conference. Record discussions and agreements and furnish a copy to each participant.

   2. Chain link tree protection fence will be used in locations where construction is within ten (10) feet to fifty (50) of the dripline of a tree stand and orange vinyl fence where construction is greater than fifty (50) feet from the dripline. Contractor shall propose locations of chain link and vinyl to Owner including the Natural Resource coordinator and receive approval before installing fence.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Drainage Fill: Selected crushed stone, or crushed or uncrushed gravel, washed, ASTM D 448, Size 24, with 90 to 100 percent passing a 2-1/2-inch sieve and not more than 10 percent passing a 3/4-inch sieve.

B. Topsoil: Fertile, friable, surface soil, containing natural loam and complying with ASTM D 5268. Provide topsoil that is free of stones larger than 1 inch in any dimension and free of other extraneous or toxic matter harmful to plant growth. Obtain topsoil only from well-drained sites where soil occurs in depth of 4 inches or more; do not obtain from bogs or marshes.

C. Chain Link: Metallic-coated steel chain link fence fabric, 0.120-inch- (3-mm-) diameter wire size; 48 inches (1200 mm) high, minimum; with tie wires, hog ring ties, and other accessories for a complete fence system.

D. Orange Vinyl Fence: Fabric shall be 48” height and constructed of orange plastic mesh containing ultraviolet stabilizers to prevent degradation, with maximum aperture openings of 4.5 square inches, and have minimal tensile strength of 250 pounds per foot in the longitudinal direction and 150 pounds per foot in the vertical direction.
PART 3 - EXECUTION

3.1 PREPARATION

A. Temporary Fencing: Install temporary fencing located as indicated or outside the drip line of trees to protect remaining vegetation from construction damage.

1. Install 8 foot steel drive-in fence posts (13 gage) approximately 8 feet on center maximum, along drip-line of trees.

2. Insert steel drive-in posts a minimum of 3 feet into ground, leaving 5 feet above ground.

3. Secure Chain link or orange vinyl fence to posts.

B. Protect tree root systems from damage due to noxious materials caused by runoff or spillage while mixing, placing, or storing construction materials. Protect root systems from flooding, eroding, or excessive wetting caused by dewatering operations.

C. Do not store construction materials, debris, or excavated material within the drip line of remaining trees. Do not permit vehicles or foot traffic within the drip line; prevent soil compaction over root systems.

D. Do not allow fires under or adjacent to remaining trees or other plants.

3.2 EXCAVATION

A. Install shoring or other protective support systems to minimize sloping or benching of excavations.

B. Do not excavate within drip line of trees, unless otherwise indicated.

C. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks and comb soil to expose roots. Coordinate all activities with Owner / Natural Resources coordinator prior to commencing trenching and excavation work.

1. Relocate roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and relocate them without breaking. If encountered immediately adjacent to location of new construction and relocation is not practical; cut roots approximately 3 inches back from new construction.

2. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

D. Where utility trenches are required within drip line of trees, tunnel under or around roots by drilling, auger boring, pipe jacking, or digging by hand.

1. Root Pruning: Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots with sharp pruning instruments; do not break or chop.
3.3 REGRADING

A. Grade Lowering: Where new finish grade is indicated below existing grade around trees, slope grade beyond drip line of trees. Maintain existing grades within drip line of trees.

B. Minor Fill: Where existing grade is 6 inches or less below elevation of finish grade, fill with topsoil. Place topsoil in a single uncompacted layer and hand grade to required finish elevations.

C. Moderate Fill: Where existing grade is more than 6 inches, but less than 12 inches, below elevation of finish grade, place drainage fill, filter fabric, and topsoil on existing grade as follows:

1. Carefully place drainage fill against tree trunk approximately 2 inches above elevation of finish grade and extend not less than 18 inches from tree trunk on all sides. For balance of area within drip-line perimeter, place drainage fill up to 6 inches below elevation of grade.
2. Place filter fabric with edges overlapping 6 inches minimum.
3. Place fill layer of topsoil to finish grade. Do not compact drainage fill or topsoil. Hand grade to required finish elevations.

3.4 TREE PRUNING

A. Contractor must receive permission from Owner before commencing with pruning operations. Prune remaining trees affected by temporary and new construction.

B. Prune remaining trees to compensate for root loss caused by damaging or cutting root system. Provide subsequent maintenance during Contract period as recommended by qualified Arborist.

C. Pruning Standards: Prune trees according to ANSI A300 as follows:

1. Type of Pruning: Crown cleaning.
2. Type of Pruning: Crown thinning.
3. Type of Pruning: Crown raising.
4. Type of Pruning: Crown reduction.
5. Type of Pruning: Vista pruning.
6. Type of Pruning: Crown restoration.

D. Cut branches with sharp pruning instruments; do not break or chop.

E. Chip branches removed from trees. Spread chips where indicated or as directed by Landscape Architect with Owner’s approval.

3.5 TREE REPAIR AND REPLACEMENT

A. Promptly repair trees damaged by construction operations within 24 hours. Treat damaged trunks, limbs, and roots according to written instructions of the qualified Arborist.

B. Remove and replace dead and damaged trees that the qualified Arborist determines to be incapable of restoring to a normal growth pattern.
TEMPORARY TREE AND PLANT PROTECTION

1. There shall be no trees greater than 4 inches in caliper size removed without the consent of the Owner and Landscape Architect.

2. Provide new trees of 2 inch caliper size and of a species selected by Landscape Architect when trees more than 4 inches in caliper size, measured 12 inches above grade, are required to be replaced.

C. Aerate surface soil, compacted during construction, 10 feet beyond drip line and no closer than 36 inches to tree trunk. Drill 2-inch diameter holes a minimum of 12 inches deep at 24 inches o.c. Backfill holes with an equal mix of augered soil and sand.

3.6 DISPOSAL OF WASTE MATERIALS

A. Burning is not permitted.

B. Disposal: Remove excess excavated material, displaced trees, and excess chips from Owner's property.

END OF SECTION 015639
SECTION 015723

TEMPORARY STORM WATER POLLUTION CONTROL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Implementation of temporary storm water pollution controls during construction as required by the Texas Commission on Environmental Quality's Texas Pollutant Discharge Elimination System (TPDES) Program’s requirements.

B. Installation and maintenance of storm water pollution control best management practices, temporary construction entrance/exit, curb inlet protection, filter fabric fence, concrete washout area and erosion control blankets.

C. Contractor to follow drawings for temporary erosion control details.

1.2 REFERENCE STANDARDS

A. ASTM


2. D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).


1.3 CONTROL DESCRIPTIONS

A. Reinforced Filter Fabric Fence: Install to allow surface or channel runoff percolation through fabric in sheet-flow manner and to retain and accumulate sediment. Maintain Filter Fabric Fences to remain in proper position and configuration at all times.

1.4 SUBMITTALS

A. Submittals shall conform to requirements General Conditions

B. Submit manufacturer's literature for product specifications and installation instructions.

C. Submit manufacturer’s catalog sheets and other product data on geotextile or filter fabrics, outlet pipe, perforated riser and connectors.

D. Submit proposed methods, equipment, materials, and sequence of operations for storm water pollution prevention structures.

PART 2 - PRODUCTS

2.1 AGGREGATE MATERIALS

A. Use poorly graded cobbles with diameter greater than 3 inches and less than 5 inches.

B. Provide clean cobbles and gravel consisting of crushed concrete or stone. Use clean, hard crushed concrete or stone free from adherent coatings, salt, alkali, dirt, clay, loam, shale, soft or flaky materials, or organic matter.

C. Sediment Pump Pit Aggregate: Use nominal 2-inch diameter river gravel.

2.2 GEOTEXTILE FILTER FABRIC

A. Woven or nonwoven geotextile filter fabric made of either polypropylene, polyethylene, ethylene, or polyamide material, in continuous rolls of longest practical length.

B. Grab Strength: 100 psi in any principal direction (ASTM D-4632), Mullen burst strength >200 psi (ASTM D-3786), and equivalent opening size between 50 and 140.

C. Furnish ultraviolet inhibitors and stabilizers for minimum 6 months of expected usable construction life at temperature range of 0 degrees F to 120 degrees F.
2.3 FENCING

A. Wire Fencing: Woven galvanized steel wire, 14 gauge by 6-inch square mesh spacing, minimum 24 inch roll or sheet width of longest practical length.

B. Fence Stakes: Nominal 2 by 2 inch moisture-resistant treated wood or steel posts (min. of 1.25 lbs. per linear foot and Brinell Hardness greater than 140) with safety caps on top; length as required for minimum 8 inch bury and full height of filter fabric.

PART 3 - EXECUTION

3.1 PREPARATION, INSTALLATION AND MAINTAINANCE

A. Provide erosion and sediment control structures at locations shown on the Drawings.

B. Do not clear, grub or rough cut until erosion and sediment control systems are in place unless approved by Engineer to allow installation of erosion and sediment control systems, soil testing and surveying.

C. Maintain existing erosion and sediment control systems located within project site until acceptance of Project or until directed by Engineer to remove and discard existing system.

D. Regularly inspect and repair or replace damaged components of erosion and sediment control structures. Unless otherwise directed, maintain erosion and sediment control structure until project area stabilization is accepted. Redress and replace granular fill at outlets as needed to replenish depleted granular fill. Remove erosion and sediment control structures promptly when directed by Engineer.

E. Remove and dispose sediment deposits at the designated spoil site for the Project. If a project spoil site is not designated on Drawings, dispose of sediment off site at approved location.

F. Prohibit equipment and vehicles from maneuvering on areas outside of dedicated right of way and easements for construction. Immediately repair damage caused by construction traffic to erosion and sediment control structures.

G. Protect existing trees and plants within the project limits as required in drawings and specifications.
3.2 FILTER FABRIC FENCE CONSTRUCTION METHODS

A. Filter Fabric Fence:

1. Install stakes 3 feet on center maximum and firmly embed minimum 8 inches in soil. If filter fabric is factory preassembled with support netting, then maximum support spacing is 8 feet. Install wood stakes at a slight angle toward the source of anticipated runoff.

2. Trench in the toe of the fence lines so the downward face of the trenches is flat and perpendicular to direction of flow. V-trench configuration as shown on Drawings may also be used.

3. Lay fabric along edges of trenches in longest practical continuous runs to minimize joints. Make joints only at a support post. Splice with minimum 6-inch overlap and seal securely.


5. Backfill and compact trench.

B. Reinforced Filter Fabric Fence:

1. Layout fence same as for Type 1.

2. Install stakes at 6 feet on center maximum and at each joint in wire fence, firmly embedded 1-foot minimum, and inclined it as for Type 1.

3. Tie wire fence to stakes with wire at 6 inches on center maximum. Overlap joints minimum one bay of mesh.

4. Install trench same as for Type 1.

5. Fasten filter fabric wire fence with tie wires at 3 inches on center maximum.

6. Layout fabric same as for Type 1. Fasten to wire fence with wire ties at 3 inches on center maximum and, if applicable, to stakes above top of wire fence it as for Type 1.

7. Backfill and compact trench.

C. Attach filter fabric to wooden fence stakes spaced a maximum of 6 feet apart or steel fence stakes spaced a maximum of 8 feet apart and embedded a minimum of 12 inches. Install stakes at a slight angle toward source of anticipated runoff.
D. Trench in toe of filter fabric fence with spade or mechanical trencher so that downward face of trench is flat and perpendicular to direction of flow. A V-trench configuration may also be used. Lay filter fabric along edges of trench. Backfill and compact trench upon completion of Construction.

E. Filter fabric fence shall have a minimum height of 18 inches and a maximum height of 36 inches above natural ground.

F. Cut length of fence to minimize use of joints. When joints are necessary, splice fabric together only at support post with minimum 6 inch overlap and seal securely.

G. Triangular Filter Fabric Fence Construction Methods


2. Secure triangular fabric filter fence in place using one of the following methods:
   a. Toe-in skirt 6 inches with mechanically compacted material;
   b. Weight down skirt with continuous layer of 3-inch to 5-inch graded rock; or
   c. Trench-in entire structure 4 inches.

3. Anchor triangular fabric filter fence structure and skirt securely in place using 6-inch wire staples on 2-foot centers on both edges and on skirt, or staked using 18-inch by 3/8-inch diameter re-bar with tee ends.

4. Lap fabric filter material by 6 inches to cover segment joints. Fasten joints with galvanized shoat rings.

H. Reinforced Filter Fabric Barrier Construction Methods

1. Attach woven wire fence to fence stakes.

2. Securely fasten filter fabric material to wire fence with tie wires.

3. When used in swales, ditches or diversions, elevation of barrier at top of filter fabric at flow line location in channel shall be lower than bottom elevation of filter fabric at ends of barrier or top of bank, whichever is less, in order to keep storm water discharge in channel from overtopping bank.

4. Remove sediment deposits when silt reaches depth one-third height of barrier or 6 inches, whichever is less.
3.3 STREETS AND PARKING AREAS CLEANING

A. Keep streets and parking areas clean of construction debris and mud carried by construction vehicles and equipment. If necessary, install stabilized construction exits at construction, staging, storage, and disposal areas, per details on Sheet C304.

B. In lieu of or in addition to stabilized construction exits, shovel or sweep pavements as required to keep areas clean. Do not water hose or sweep debris and mud off street into adjacent areas, except, hose sidewalks during off-peak hours, after sweeping.

3.4 WASTE COLLECTION AREAS

A. Prevent water runoff from passing through waste collection areas, and prevent water runoff from waste collection areas migrating outside collection areas.

3.5 EQUIPMENT MAINTENANCE AND REPAIR

A. Confine maintenance and repair of construction machinery and equipment to areas specifically designated for that purpose, so fuels, lubricants, solvents, and other potential pollutants are not washed directly into receiving streams or storm water conveyance systems. Provide these areas with adequate waste disposal receptacles for liquid and solid waste. Clean and inspect maintenance areas daily.

B. Where designated equipment maintenance areas are not feasible, take precautions during each individual repair or maintenance operation to prevent potential pollutants from washing into streams or conveyance systems. Provide temporary waste disposal receptacles.

3.6 VEHICLE/EQUIPMENT WASHING AREAS

A. Install wash area (stabilized with coarse aggregate) adjacent to stabilized construction exit(s), as required to prevent mud and dirt run-off. Release wash water into drainage swales or inlets protected by erosion and sediment controls.

B. Wash vehicles only at designated wash areas. Do not wash vehicles such as concrete delivery trucks or dump trucks and other construction equipment at locations where runoff flows directly into watercourses or storm water conveyance systems.

C. Locate wash areas to spread out and evaporate or infiltrate wash water directly into ground, or collect runoff in temporary holding or seepage basins.

3.7 WATER RUNOFF AND EROSION CONTROL

A. Control surface water, runoff, subsurface water, and water from excavations and structures to prevent damage to the Work, the site, or adjoining properties.

B. Control fill, grading and ditching to direct water away from excavations, pits, tunnels, and other construction areas, and to direct drainage to proper runoff courses to prevent erosion, sedimentation or damage.
C. Provide, operate, and maintain equipment and facilities of adequate size to control surface water.

D. Dispose of drainage water to prevent flooding, erosion, or other damage to the site or adjoining areas. Follow environmental requirements.

E. Retain existing drainage patterns external to the site by constructing temporary earth berms, sedimentation basins, retaining areas, and temporary ground cover as required to control conditions.

F. Plan and execute construction and earth work to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation.

1. Hold area of bare soil exposed at one time to a minimum.
2. Provide temporary controls such as berms, dikes, and drains.

G. Construct fill and waste areas by selective placement to eliminate surface silts or clays which will erode.

H. Inspect earthwork periodically to detect start of erosion. Immediately apply corrective measures as required to control erosion.

I. Dispose of sediments offsite, not in or adjacent to streams or floodplains, nor allow sediments to flush into streams or drainage ways. Assume responsibility or offsite disposal location.

J. Unless otherwise indicated, compact embankments, excavations, and trenches by mechanically blading, tamping, and rolling soil in maximum of 8-inch layers. Provide compaction density at minimum 95 percent Standard Proctor ASTM D-698-78 density. Make at least one test per 500 cubic yards of embankment.

K. Do not maneuver vehicles on areas outside of dedicated rights-of-way and easements for construction. Immediately repair damage to erosion and sedimentation control systems caused by construction traffic.

L. Do not damage existing trees intended to remain.

3.8 REMOVAL OF CONTROLS

A. Remove erosion and sediment controls when the site is finally stabilized or as directed by Engineer.

B. Dispose of sediments and waste products as required by the Engineer.

END OF SECTION 015723
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

1. Construction phasing.
2. Construction layout.
3. Construction access and egress plan.
4. Installation of the Work.
5. Cutting and patching.
6. Protection and Restoration of Site.
7. Progress cleaning.
8. Starting and adjusting.
10. Pre-Installation Meeting for Temporary Tree and Plant Protection

1.3 SUBMITTALS

A. Prior to mobilization, provide a construction phasing plan showing staging areas, limits of work, dates of work, locations of access and egress routes and location of stockpile areas for review and approval by the Engineer.

B. Prior to construction, submit a video of the staging areas, access and egress routes and stockpile locations.

C. Submit a waste management recycling and off-site disposal plan.

1.4 QUALITY ASSURANCE

A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

B. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.

2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operational elements include the following:
   a. Communication systems.
   b. Electrical wiring systems.
   c. Plumbing systems.

3. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

C. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

D. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

C. Wooden Mats: Wooden mats shall be constructed of untreated hardwood timber up to 12-inches thick and 10 to 20 feet in length. Width of mats shall be determined by the type of equipment to be supported.

PART 3 - EXECUTION

3.1 EXAMINATION – PRE-CONSTRUCTION

A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning site work, Contractor
shall investigate and verify the existence and location of underground utilities, mechanical and electrical systems, IT cabling and other construction affecting the Work.

1. Prior to construction, verify survey information provided in the drawings and notify Engineer of any discrepancy.
2. Prior to construction, field verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, IT cabling and other utilities.
3. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

D. Cedar Hill State Park adjoins Joe Pool Lake. Joe Pool Lake is operated by the U.S. Army Corps of Engineers (USACE) for municipal water supply, flood control and recreational purposes. The normal conservation pool elevation (and Ordinary High Water Mark) for the lake is elevation 522.0’ above NGVD29. Significant portions of the project area are located below elevation 541.0’ above NGVD29, which is the elevation of the emergency spillway crest and the elevation to which the USACE can impound flood waters.

E. This project is governed by the requirements of the US Army Corps of Engineers Nationwide Permit 42. Jurisdictional wetlands and Waters of the United States exist in the project area. The wetland areas are shown on the drawings and are to be avoided to the maximum extent possible. When work is shown in or near the wetland areas, the Contractor shall place wooden mats for access by equipment within all designated wetland areas. Equipment is not to be driven or moved through or in wetland areas without the use of wooded mats. Mats shall be laid and retrieved to minimize environmental impact to the wetlands. At the completion of the work and after removal of the wooden mats, the Contractor shall restore the wetland elevations to pre-construction elevations.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before
C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect according to requirements of the contract conditions.

E. Pre-Installation Meeting for Temporary Tree and Plant Protection: See requirements in Specification Section 015639 – Temporary Tree and Plant Protection.

3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify survey and layout information shown on Drawings, in relation to the survey elevations and existing benchmarks. If discrepancies are discovered, notify Engineer promptly.

B. General: Engage a land surveyor to lay out the Work using accepted surveying practices.

1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
2. Establish limits on use of Project site.
3. Establish dimensions within tolerances indicated.
4. Inform installers of lines and levels to which they must comply.
5. Check the location, level and plumb, of every major element as the Work progresses.
6. Notify Engineer when deviations from required lines and levels exceed allowable tolerances.
7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

C. Install temporary erosion protection controls and tree protection systems prior to commencing other construction activities.

D. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.

E. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work for review and approval by Engineer. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

F. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.
3.4 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb and make horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.

F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.

   1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
   2. Allow for building movement, including thermal expansion and contraction.
   3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.
3.5 PROTECTION AND RESTORATION OF SITE

A. Contractor shall protect existing park features (roads, parking areas, trees and landscaping, pavilion, vegetated areas, utilities, etc.) not scheduled for construction. If damaged, Contractor shall restore park features to pre-construction condition at no additional cost to the Owner.

B. This project is governed by the requirements of the US Army Corps of Engineers Nationwide Permit 42. Jurisdictional wetlands and Waters of the United States exist in the project area. The wetland areas are shown on the drawings and are to be avoided to the maximum extent possible. When work is shown in or near the wetland areas, the Contractor shall place wooden mats for access by equipment within all designated wetland areas. Equipment is not to be driven or moved through or in wetland areas without the use of wooded mats. Mats shall be laid and retrieved to minimize environmental impact to the wetlands. At the completion of the work and after removal of the wooden mats, the Contractor shall restore the wetland elevations to pre-construction elevations.

3.6 CUTTING AND PATCHING

A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Temporary Support: Provide temporary support of work to be cut.

C. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

D. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.

E. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete, Asphaltic Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
6. Proceed with patching after construction operations requiring cutting are complete.

F. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
   a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
   b. Restore damaged pipe covering to its original condition.
3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
   a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
   b. Waterproofed Concrete: Patch waterproofed concrete with products designed to restore waterproofing through depth of repair.
4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.

G. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.7 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.

2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
   a. Use containers intended for holding waste materials of type to be stored.
4. Coordinate progress cleaning for joint-use areas.
B. Site: Maintain project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
   1. Remove liquid spills promptly.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Legally dispose of all waste off-site.

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.8 STARTING AND ADJUSTING

A. Start all equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.9 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Comply with manufacturer's written instructions for temperature and relative humidity.
PART 1 - GENERAL

1.1 REFERENCE STANDARDS

A. American Concrete Institute (ACI):
   315, Details and Detailing of Concrete Reinforcement
   318, Building Code Requirements for Reinforced Concrete

B. American Society for Testing and Materials (ASTM):
   A 615, Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

C. Concrete Reinforcing Steel Institute (CRSI):
   Placing Reinforcing Bars

1.2 SUBMITTALS

A. Shop Drawings: Show reinforcing bar configuration, bar numbers, spacing, and location, and splicing details.

B. Test Reports: Submit copies of mill test reports.

1.3 QUALITY ASSURANCE

A. Tolerances:
   1. Fabricating tolerances:
      a. Sheared length: Plus or minus 1-in.
      b. Depth of truss bars: Plus 0, minus 1/2-in.
      c. Overall dimensions of stirrups and ties: Plus or minus 1/2-in.
      d. Other bends: Plus or minus 1-in.

   2. Placing tolerances:
      a. Clear distance to formed surfaces: Plus or minus 1/4-in.
      b. Minimum spacing between bars: Plus or minus 1/4-in.
      c. Top bars in slabs and beams:
         (1) Members 8-in. deep or less: Plus or minus 1/4-in.
         (2) Members more than 8-in. but not over 2 ft. deep: Plus or minus 1-in.
      d. Crosswise of members: Spaced evenly within 2-in.
      e. Lengthwise of member: Plus or minus 2-in.
PART 2 - PRODUCTS

2.1 MATERIALS

A. Reinforcing Bars:

1. ASTM A 615, Grade 60.
2. Bend test requirements: For bars size No. 3 through No. 6, base on 180 deg. bends of full size bars around pins with diameters as follows:
   a. Bar Nos. 3, 4, and 5: 3-1/2 bar diameters.
   b. Bar No. 6: 5 bar diameters.

2.2 FABRICATION

A. Fabricate details of concrete reinforcement and accessories complying with ACI 315.

PART 3 - EXECUTION

3.1 HANDLING AND PLACING

A. Place reinforcing bars in accordance with CRSI "Placing Reinforcing Bars" and ACI 318, with provisions of ACI 318 governing.

B. Move bars as necessary to avoid interference with other reinforcing steel, conduits, or embedded items.

C. If bars are moved more than one bar diameter or enough to exceed tolerances, submit resulting arrangement of bars to Engineer for review.

D. After fabrication, reinforcing bars shall be delivered to the Work properly identified in accordance with the approved shop drawings.

E. Place reinforcement, at time of concrete placing, free of mud, oil, or other materials that adversely affect or reduce bond.

F. Reinforcement with rust, mill scale, or both shall be considered satisfactory, provided minimum dimensions, including height of deformation, and weight of hand-wire-brushed test specimen are not less than ASTM A 615 requirements.

G. Support reinforcement and fasten together to prevent displacement by construction loads of placing concrete.

H. Use metal or plastic bar chairs and spacers to support reinforcement.

I. Where concrete surface will be exposed to weather in finished structure, use noncorrosive or corrosion protected accessories within 1/2-in. of concrete surface.

J. Bars having splices not shown on shop drawings will be rejected.

K. Do not bend reinforcement after being embedded in hardened concrete.

END OF SECTION 032000
SECTION 033000

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

A. American Concrete Institute (ACI):
   212.1R, Admixtures for Concrete
   212.2R, Use of Admixtures in Concrete
   302.1R, Concrete Floor and Slab Construction
   204R, Measuring, Mixing, Transporting, and Placing Concrete
   305R, Hot Weather Concreting
   306R, Cold Weather Concreting
   308, Standard Practice for Curing Concrete
   309R, Consolidation of Concrete

B. American Society for Testing and Materials (ASTM):
   A 307, Carbon Steel Bolts and Studs 60,000 psi Tensile Strength
   A 36, Structural Steel
   C 138, Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
   C 143, Slump of Portland Cement Concrete
   C 150, Portland Cement
   C 172, Sampling Freshly Mixed Concrete
   C 173, Air Content of Freshly Mixed Concrete by the Volumetric Method
   C 192, Making and Curing Concrete Test Specimens in the Laboratory
   C 231, Air Content of Freshly Mixed Concrete by the Pressure Method
   C 260, Air-Entraining Admixtures for Concrete
   C 293, Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading)
   C 309, Liquid Membrane-Forming Compounds for Curing Concrete
   C 31, Making and Curing Concrete Test Specimens in the Field
   C 33, Concrete Aggregates
   C 387, Packaged, Dry, Combined Materials for Mortar and Concrete
   C 39, Compressive Strength of Cylindrical Concrete Specimens
   C 494, Chemical Admixtures for Concrete
   C 78, Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
   C 920, Joint Sealant
   C 94, Ready-Mixed Concrete
   D 1751, Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
   D 1752, Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
   D 994, Preformed Expansion Joint Filler for Concrete (Bituminous Type)

C. Concrete Plant Manufacturers Bureau (CPMB):
   Concrete Plant Mixer Standards of Plant Mixer Manufacturers Division
D. Corps of Engineers (COE):
   CRD-C300, Handbook for Concrete and Cement
   CRD-C621, Handbook for Concrete and Cement

E. Federal Specifications (FS):
   FF-S-325, Shield, Expansion; Nail Expansion; and Nail, Drive Screw (Devices,
   Anchoring, Masonry)

1.2 SUBMITTALS

A. Product Data: Submit literature of proposed materials certifying compliance with
   specification requirements and curing procedures.

B. Mill Reports: Furnish mill certificate with each shipment of cement showing
   chemistry and physical tests for autoclave soundness, heat of hydration, normal
   consistency false set, and time of set.

C. Design Mix:
   1. Submit proposed design mix from job materials prepared by approved testing
      laboratory when concrete proportioning Method No. 1 is used (See
      Paragraph 2.3, C.,1).
   2. Submit test records when concrete proportioning Method No. 2 is used (See
      Paragraph 2.3, C., 2).
   3. Include following information in concrete mix design submittal:
      a. Concrete supplier.
      b. Design mix designation and location of concrete in work.
      d. Type and brand of cement.
      e. Source of aggregate.
      f. Sieve analysis of aggregate.
      g. Type and brand of admixtures.
      h. Strength curve relationship to water-cement ratios established by at
         least three points of curve with each point established by average of
         three cylinder breaks using job materials.
      i. Coarse Aggregate Factor (C.A.F.)
      j. Batch weights of ingredients.
      k. Water-Cement ratio and cement content.
      l. Air content.
      m. Slump.
      n. Seven day and 28 day strengths.

D. Samples: Secure in accordance with ASTM C 172.

E. Shop Drawings:
   1. Indicate location of control, construction, and expansion joints.
   2. Indicate location and size of anchor bolts, anchor plates and other similar
3. Indicate placement sequence of concrete.

1.3 QUALITY ASSURANCE

A. Owner's Quality Control Laboratory:

1. Sample and test concrete ingredients.
2. Mixes shall meet or exceed mix design strength requirements and use and finish requirements.
3. Review proposed mix design or design mix to meet or exceed mix design strength and consistency requirements as specified in "Concrete Mix Requirements" and "Concrete Proportioning".
4. Test production samples of materials at plants and stockpiles and at job site during course of work for compliance with specifications.
5. Conduct tests of concrete during construction in compliance with following procedures:

a. Strength test:
   (1) Make specimens in field.
   (2) Each test shall consist of four cylinders; two tested at seven days and two tested at 28 days.
   (3) For each class of concrete, one test for each pour of 100 cubic yards shall be made; however, not less than one test for each day of concreting shall be made.
   (4) When this schedule of testing proves less than five tests for given class of concrete, at least five randomly selected batches shall be tested; if fewer than five batches are used, each batch shall be tested.
   (5) Additional tests may be required to justify removal of formwork.
   (6) Specimens shall be secured in compliance with ASTM C 172, made and cured in compliance with ASTM C 31, and tested in compliance with ASTM C 39.

b. Slump test: Make one test for each strength test in compliance with ASTM C 143.
c. Air Content test: Make one test for each strength test in compliance with ASTM C 173 or ASTM C 231.
d. Report test results: Report test results to Owner and Contractor.
e. Maintain records: Maintain complete record of specimens; records shall include detailed location of each pour represented.
f. Determine temperature of concrete sample for each strength test.
g. Inspect concrete batching, mixing, and delivery operations.
h. Sample concrete at point of placement.
i. Indicate in report location specimens were taken, method stored and curing procedures.

6. Determine slump in accordance with ASTM C 143 of concrete sample for each strength test and when consistency of concrete appears to vary.
7. Determine air content of normal weight concrete for each strength test in accordance with ASTM C 138, ASTM C 173, or ASTM C 231.

8. Patching Core Holes:
   a. Fill core holes with SikaSet Roadway Patch, Sika Corporation, as per manufacturer's specification or approved equal.

1.4 HANDLING

A. Storage:
   1. Store materials in accordance with ACI 304R.
   2. Store admixtures to avoid contamination, evaporation, or damage.

B. Protection:
   1. During curing period, protect concrete from damaging mechanical disturbances, load stresses, shock, and vibration.
   2. Protect finished concrete surfaces from damage by construction equipment or materials.
   3. Protect from rain or running water.

PART 2 - PRODUCTS

2.1 CONCRETE AND GROUT MATERIALS

A. General:
   1. Flyash may be used to replace a portion of cement. The ratio of flyash to the total of the flyash and cement in a mix shall not exceed 20%. Flyash shall conform to ASTM C618, Type C or F.
   2. Admixtures, other than air-entraining admixtures and water-reducing admixtures in compliance with ASTM C 494, shall not be used in concrete mixtures without prior review of material and proportioning by Owner.

B. Cement: ASTM C 150, Type I.

C. Concrete Admixtures:
   1. Acceptable manufacturers:
      a. Master Builder.
      c. Sika Chemical Corp.
   3. Water-reducing, normal set, retarding, and accelerating admixtures:
      a. Concrete temperatures 80 deg. F. and below: ASTM C 494, Type A.
b. Concrete temperatures greater than 80 deg. F.: ASTM C 494, Type D.
c. Concrete temperatures 60 deg. F. and below: ASTM C 494, Type E, accelerating.

4. Other admixtures: ASTM C 494.

D. Water: Fresh, clean, and potable.

E. Aggregates for Normal Weight Concrete: ASTM C 33.


H. Nonshrink Grout:
   1. Non-metallic, pre-mixed nonshrink grout complying with COE CRD-C621.

I. Stud Anchors:
   1. Acceptable manufacturers:
      b. Erico Products, Inc.
   2. Type with ceramic ferrules; compatible with arc-welding process.

J. Expansion Bolts:
   1. Acceptable manufacturers:
      a. Hilti Fastener Company.
      b. Simpson or equal.
   2. Wedge type stainless steel, FS FF-S-325, Group II, Type 4, Class 1.

K. Curing Compound:
   1. Comply with COE CRD-C300.
   2. Application rate shall not exceed 150 square feet per gallon.
   3. Unit moisture loss, g. per sq. cm. at 72 hr. shall not exceed 0.039.
   4. Acceptable products:
      c. "Dress and Seal", L and M Construction Chemicals, Inc.
L. Joint Sealant:
   1. Two – component elastomeric chemical – cure polyurethane
   2. ASTM C920, Type M, Grade P

2.2 CONCRETE MIX REQUIREMENTS

A. Strength:  Base strength requirements on 28-day compressive strength.  
   Also see specification 321313 – Concrete Paving

B. Mixture Limits:
   1. Air-entrainment of normal-weight concrete shall conform to content limits of  
      Table I, as measured by ASTM C 138, ASTM C 173, and ASTM C 231:

      | Nominal Max. Size of Coarse Aggregate (ASTM C 33) | Total Air Content No. | Content Percent by Volume |
      |--------------------------------------------------|-----------------------|---------------------------|
      | 1”                                               | 57                    | 3.5-6.5                   |

   2. Grading for coarse aggregate shall not exceed limits for various size number  
      designation in compliance with ASTM C 33 for various maximum nominal  
      sizes.

   3. Water used for mixing concrete, including water absorbed by aggregates and  
      admixture, shall not contain more than 150 ppm of chloride ion.

C. Slump:
   1. Slump shall be 4 inches to 5 inches in accordance with ASTM C 143.

D. Admixtures:
   1. Comply with ACI 212.1R and ACI 212.2R.
   2. Do not use calcium chloride.
   3. Use admixtures in accordance with manufacturer’s instructions.
   4. Use only admixtures in work used in establishing design mix.
   5. Water-reducing admixtures, or other admixtures accepted by Owner, may be  
      used to produce quality of concrete specified under prevailing placing  
      conditions.
2.3 CONCRETE PROPORTIONING

A. General:

1. Proportion ingredients to produce mixture which will work readily into corners and angles of forms and around reinforcement under conditions of placement to be employed without excessive segregation of materials or excessive collection of free water on surface or excessive bleeding out of free water.

2. Proportion ingredients to produce mixture of required workability, placeability, durability, strength, and other specified properties.

B. Required Strength:

<table>
<thead>
<tr>
<th>Type of Construction</th>
<th>Minimum Compressive Strength psi. (28 days)</th>
<th>Total Air (Percent)</th>
<th>Minimum Cement Factor* (Bags/cu.yd.)</th>
<th>Maximum W/C Ratio* (Gals/bg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pavement</td>
<td>See Specification</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>321313 – Concrete Paving</td>
<td>3000</td>
<td>4.0</td>
<td>6.0</td>
<td>.40</td>
</tr>
<tr>
<td>Floor Slabs/Grade Beams</td>
<td>3000</td>
<td>4.0</td>
<td>6.0</td>
<td>.40</td>
</tr>
<tr>
<td>Footings</td>
<td>3000</td>
<td>4.0-5.0</td>
<td>6.0</td>
<td>.40</td>
</tr>
<tr>
<td>All Other Concrete</td>
<td>3000 or greater</td>
<td>4.0-5.0</td>
<td>6.0</td>
<td>.40</td>
</tr>
<tr>
<td></td>
<td>(see plans)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* In some instances, maximum water-cement ratios and minimum cement factors may not be compatible due to aggregate characteristics or weather conditions. Under these conditions, water reducing admixture may be introduced into mix. In hot weather, retarding admixture may be added to mix in accordance with manufacturer's recommendations.

NOTE: Do not add air into concrete for slab-on-grade.

C. Normal Weight Concrete: Establish mixture proportions to provide required properties for each class of concrete using one of the methods described below.
1. Method No. 1:
   a. Using materials proposed for work, establish concrete proportions on basis of laboratory trial mixes.
   b. Make at least three trial batches of at least three cylinders per batch at different water-cement ratios which will produce range of strengths within 1000 psi of that specified for each class of concrete for proposed work.
   c. Make trial batches to produce maximum slump within plus or minus 0.75-in. and maximum allowable air content within plus or minus 0.5 percent.
   d. Make and cure cylinders complying with ASTM C 192.
   e. Test for strength at 28 days in accordance with ASTM C 39.
   f. Use results of tests to plot curve showing relationship between water-cement ratio and compressive strength.
   g. For each class of concrete select design water-cement ratio from this curve for average compressive strength 1200 psi greater than specified compressive strength, except that water-cement ratio shall not exceed 6.6 gallons of water per sack (94 lb.) of cement.

2. Method No. 2:
   a. Field test data for concrete made with similar ingredients in previous project may be used to establish mix design for each class of concrete.
   b. Where production facility has record based on 30 consecutive strength tests that represent similar materials and conditions to those expected for each class of concrete, average compressive strength used as basis for selecting proportions shall exceed specified compressive design strength for each class by at least:
      (1) 400 psi if standard deviation is less than 300 psi.
      (2) 550 psi if standard deviation is 300 to 400 psi.
      (3) 700 psi if standard deviation is 400 to 500 psi.
      (4) 900 psi if standard deviation is 500 to 600 psi.
      (5) 1200 psi if standard deviation is above 600 or unknown.
   c. Strength test data used to determine standard deviation for each class for above requirement shall represent concrete produced to meet specified design compressive strengths within 1000 psi of that specified for proposed work.
   d. For each class of concrete, select water-cement ratio based on Method 2 except that design water-cement ratio shall not exceed 6.6 gallons of water per sack (94 lb.) of cement.

2.4 PRODUCTION OF CONCRETE
   A. Ready Mixed Concrete: Batch mix and transport in accordance with ASTM C 94.
PART 3 - EXECUTION

3.1 INSPECTION FOR CONCRETE PLACEMENT

A. Inspect subgrade for conditions detrimental to work and for specified compacted density.

B. Inspect formwork and reinforcing for compliance with specified tolerances.

C. Do not proceed with work until unsatisfactory conditions are corrected.

3.2 EMBEDDED ITEMS FOR CONCRETE

A. Placing Miscellaneous Embedded Items:

1. Place sleeves, inserts, anchors, and other embedded items prior to concreting.
2. Coordinate placing of embedded items required by other trades prior to placing concrete.
3. Position embedded items accurately and support against displacement.
4. Temporarily fill voids in sleeves, inserts, and anchor slots with removable material to prevent entry of concrete into voids.

3.3 PREPARATION FOR PLACING CONCRETE

A. Remove hardened concrete and foreign materials from inner surfaces of conveying equipment.

B. Remove snow, ice, and water from completed formwork.

C. Verify that reinforcement is secured in place.

D. Verify that expansion joint material, anchors, sleeves, and other embedded items are in place.

E. Notify Owner and Engineer minimum of 24 hours before pour. If notifications are not made, Owner may stop placement of concrete.

3.4 PLACING CONCRETE

A. Conveying:

1. Comply with ASTM C 94.
2. Handle concrete as rapidly as practicable by methods which will prevent segregation, loss of ingredient, or damage quality of concrete.
3. Do not use conveying equipment that will restrict continuous placement of concrete.
4. Use horizontal or sloped belt conveyors that will not cause segregation or loss of ingredients.
5. Protect concrete against undue drying or rise in temperature.
6. Do not allow mortar to adhere to return length of belt.
7. Discharge runs longer than 20 ft. into hopper.
8. Use metal or metal lined chutes with slope not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal.
9. Chute more than 20 ft. long discharging into hoppers may be used.

B. Pumping of Concrete:
   1. Design mix to produce pumpable concrete.
   2. Pneumatic conveying equipment shall meet requirements of ACI 304R.
   3. Slump in pumping or pneumatic conveying equipment: 6-in. maximum.
   4. Do not convey through pipe made of aluminum or aluminum alloy.
   5. Obtain approval of A/E to use pumped concrete before placing pumped concrete.

C. Depositing:
   1. Comply with ACI 304R.
   2. Deposit concrete continuously without formation of seams or planes of weakness.
   3. If section cannot be placed continuously, provide construction joints.
   4. Do not start placing of concrete in supported elements until concrete previously placed is no longer plastic and has been in place two hours minimum.

D. Segregation:
   1. Deposit concrete as nearly as practicable in final position to prevent segregation due to rehandling or flowing.
   2. Do not subject concrete to procedures which will cause segregation.

E. Consolidation:
   1. Comply with ACI 309R.
   2. Consolidate concrete by vibration, spading, rodding, or forking.
   3. Thoroughly work around reinforcement, embedded items, and into corners of forms.
   4. Eliminate air or stone pockets which may cause honeycombing, pitting, or planes of weakness.
   5. Use internal vibrators with minimum frequency of 8000 vibrations per minute and sufficient amplitude to consolidate concrete effectively.
   6. Do not use vibrators to transport concrete within forms.
   7. Insert and withdraw vibrators at points approximately 18-in. apart.
   8. At each insertion, maintain duration from 5 to 15 sec. to consolidate concrete but not long enough to cause segregation.
10. Where concrete is to have as-cast finish, bring full surface of mortar against form by vibration process and supplemented by spading to work coarse aggregate back from formed surface.

11. Use internal vibration in beams, girders, slabs, and along bulkheads of slabs on grade.

3.5 REPAIR OF CONCRETE SURFACE DEFECTS

A. Preparation:

1. Repair tie holes and surface defects immediately after form removal.
2. Remove honeycombed and otherwise defective concrete down to sound concrete.
3. If chipping is necessary, place edges perpendicular to surface or slightly undercut.
4. No feathered edges will be permitted.
5. Dampen patch minimum of 6-in. of surrounding area.

B. Patching Mixture:

1. Mix one part cement to 2-1/2 parts sand by damp loose volume.
2. Match color of surrounding concrete as determined by trial patch.
3. Add water only as necessary for handling and placing.
4. Mix patching mortar in advance and allow to stand with frequent manipulation with trowel, without addition of water, until it has reached stiffest consistency that will permit placing.

C. Patch Application:

1. Apply patching mortar after bonding grout has lost sheen.
2. Thoroughly consolidate mortar into place and strike off to leave patch slightly higher than surrounding surface.
3. Leave undisturbed for one hour minimum before being finally finished.

D. Fill tie holes solid with patching mortar after cleaning and dampening.

3.6 FINISHING CONCRETE SLABS

A. Meet requirements of ACI 302.1R.

B. Finishing Tolerances:

1. True planes within 1/8-in. in 10 ft. as determined by 10 ft. straight edge placed on slab in any direction.

C. Trowel Finish all Concrete Slab Surfaces:

1. Float finish surface of concrete and trowel.
2. Finished surface shall be free of trowel marks, uniform in texture and appearance, and planed to finishing tolerance.
3. On surfaces intended to support floor coverings, remove defects which show through floor covering by grinding.

D. Trowel and Broom Finish:

1. Apply a first trowel finish to surface while concrete is still plastic slightly scarify surface with fine broom.
2. Comply with flatness and levelness tolerances of trowel floor surfaces.
3. Apply broom finish to exterior concrete platforms, steps, ramp, and elsewhere as indicated.

3.7 CURING CONCRETE

A. General:

1. Comply with ACI 308.
2. After placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
3. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration and hardening.

B. Preservation of Moisture for Concrete Surfaces not in Contact with Forms:

1. Contractor's option:
   a. Ponding or continuous sprinkling.
   b. Absorptive mats or fabric kept continuously wet.
   c. Sand kept continuously wet.
   d. Continuous application of steam not exceeding 150 deg. F. or mist spray.
   e. Curing compound:
      (1) Do not use curing compound on floor slab which will receive floor covering or chemical resistant or epoxy coating.
      (2) Apply in accordance with manufacturer's recommendations.
      (3) Do not apply to surfaces to which additional concrete or resilient materials are to be bonded unless manufacturer certifies that compound will not prevent bond or positive means are taken to completely remove compound.

2. Use curing compound on concrete surfaces where floor hardener is shown on Drawings.

C. Curing Period: Continue curing for seven days minimum or when average compressive strength of job-cured cylinders has reached 70 percent of specified strength, moisture retention measures may be terminated.

END OF SECTION 033000
SECTION 033600
SPECIAL CONCRETE FLOOR FINISHES

PART 1 GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including TPWD's Uniform General
   Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply
   to this Section.

1.2 SUMMARY
A. This section includes the following.
   1. Applying Sealer and Hardener, and polishing concrete to specified finish level.
B. Related Work:
   1. Section 033000 Cast-In-Place Concrete

1.3 REFERENCES
A. American Society for Testing and Materials:
   1. ASTM-C779, Standard Test Method for Abrasion Resistance of
      Horizontal Concrete Surfaces
   2. ASTM G23-81, Ultraviolet Light & Water Spray
   3. ASTM C805, Impact Strength
   4. ASTM C779: Abrasion
   5. ASTM C805: Hardness – 21% increase in impact resistance
   6. ASTM 1028 Coefficient of Friction and exceed OSHA, 2012 Texas Accessibility
      Standards and ADA recommendations for wet and dry surfaces.
B. American Concrete Institute
   1. ACI 302. 1R-89, Guide for Concrete Floor and Slab Construction
C. Other Test:
   1. Reflectivity
1.4 SUBMITTALS

A. Comply with pertinent provisions of TPWD’s Uniform General Conditions.

1. Provide submittal information within 35 calendar days after the contractor has received the owner's notice to proceed.

B. Product data:

1. Submit special concrete finishes manufacturer's specifications and test data.
2. Submit special concrete finishes describing product to be provided, giving manufacturer's name and product name for the specified material proposed to be provided under this section.
3. Submit special concrete finishes manufacturer's recommended installation procedures; which when approved by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the work.
4. Submit special concrete finishes technical data sheet giving descriptive data, curing time, and application requirements.
5. Submit special concrete finishes manufacturer's Material Safety Data Sheet (MSDS) and other safety requirements.
6. Follow all special concrete finishes published manufacturer's installation instructions.

C. Test Reports:

1. Provide certified test reports, prepared by an independent testing laboratory, confirming compliance with specified performance criteria.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Use an experienced installer and adequate number of skilled workmen who are thoroughly trained and experienced in the necessary craft.
2. The special concrete finish manufacturer shall certify applicator.
3. Applicator shall be familiar with the specified requirements and the methods needed for proper performance of work of this section.
4. Experience: 5 years with similar or increased size scope of projects

B. Manufacturer’s Certification:

1. Provide letter of certification from concrete finish manufacturer stating that installer is certified applicator of special concrete finishes, and is familiar with proper procedures and installation requirements required by the manufacturer.

C. Mock-ups:

1. Apply mock-ups of each type finish, to demonstrate typical joints, surface finish, color variation (if any), and standard of workmanship.
   a. Build mock-ups approximately 50 square feet in the location indicated or if not indicated, as directed by the Architect or Owner Representative.
SPECIAL CONCRETE FLOOR FINISHES

D. Protection

1. No satisfactory chemical or cleaning procedure is available to remove petroleum stains from the concrete surface. Prevention is therefore essential.
   a. All hydraulic powered equipment must be diapered to avoid staining the concrete.
   b. No trade will park vehicles on the inside slab. If necessary to complete their scope of work, drop cloths will be placed under vehicles at all times.
   c. No pipe cutting machine will be used on the inside floor slab.
   d. Steel will not be placed on interior slab to avoid rust staining.
   e. Acids and acidic detergents will not come into contact with slab.
   f. All trades informed that the slab must be protected at all times.

E. Pre-Installation Conference:

1. Conduct conference at project site to comply with requirements in TPWD’s Uniform General Conditions

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original containers, with seal’s unbroken, bearing manufacturer labels indicating brand name and directions for storage.

B. Dispense special concrete finish material from factory numbered and sealed containers. Maintain record of container numbers.

1.7 PROJECT CONDITIONS

A. Environmental limitations:

1. Comply with manufacturers written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting topping performance.
   a. Concrete Floor Flatness rating recommended at least 40, where possible.
   b. Concrete Floor Levelness rating recommended at least 30, where possible.
   c. Concrete must be cured a minimum of 45 days or as directed by the manufacturer before application of Retro Plate can begin.
   d. Application of Retro-Plate shall take place 10 days prior to installation of equipment and substantial completion, thus providing a complete, uninhibited concrete slab for application.
   e. Do NOT apply under freezing conditions.
B. Close areas to traffic during floor application and after application, for time period recommended in writing by manufacturer.

PART 2 – PRODUCTS

2.1 MATERIALS & MANUFACTURERS: Member of the Concrete Polishing Council [CPC].

A. BASIS-OF-DESIGN:

B. HARDENING/SEALING AGENT

1. Retro-Plate 99, manufactured by Advanced Floor Products, Inc., P.O. Box 50533, Provo, Utah 84605, 801-812-3420.
   a. Performance Criteria:
      i. Abrasion Resistance: ASTM C779 – Up to 400% increase in abrasion resistance.
      ii. Impact Strength: ASTM C805 – Up to 21% increase impact strength.
      iv. Reflectivity: Up to 30% increase in reflectivity.

2. Local manufacturer’s Certified Applicators, with manufacturer’s Certificate[s]

3. Manufacturer’s Regional Representative

2.2 RELATED MATERIALS

A. Neutralizing Agent:
   1. Tri-sodium Phosphate

B. Water:
   1. Potable

C. Thinners; NOT ALLOWED

PART 3- EXECUTION

3.1 SURFACE CONDITIONS:

A. Examine substrate, with installer present, for conditions affecting performance of finish. Correct conditions detrimental to timely and proper work. Do not proceed until unsatisfactory conditions are corrected.

B. Verify that base slab meet finish and surface profile requirements in Division 3 Section 033000 “Cast-In-Place Concrete,” and Project Conditions above.

C. Prior to application, verify that floor surfaces are free of construction latents.

D. Do NOT allow FIRE SPRINKLER and PLUMBING cutting, fabrication or storage/placing any piping and/or fittings to be placed/stored on finished polished concrete flooring at any time during the construction process.
3.2 APPLICATION

A. Start any of the floor finish applications in presence of manufacturer’s technical representative.

B. Sealing, Hardening and Polishing of Concrete Surface

   1. Concrete must be in place a minimum of 45 days or as directed by the manufacturer before application can begin.

   2. Application is to take place at least 10 days prior to racking and other in-store accessory installation, thus providing a complete, uninhibited concrete slab for application.

   3. Only a certified applicator shall apply Retro-Plate 99. Applicable procedures must be followed as recommended by the product manufacturer and as required to match approved test sample.

   4. Achieve waterproofing, hardening, dust-proofing, and abrasion resistance of the surface without changing the natural appearance of the concrete, except for the sheen.

   5. Polish to "Super-Polished" sheen level: Class 4 and Level 4 MIRROR FINISH with a "Salt and Pepper" effect.

   6. Do NOT burn concrete surfacing during polishing operations.

3.3 WORKMANSHIP AND CLEANING:

A. The premises shall be kept clean and free of debris at all times.

B. Remove spatter from adjoining surfaces, as necessary.

C. Repair damages to surface caused by cleaning operations.

D. Remove debris from jobsite

   1. Dispose of materials in separate, closed containers in accordance with local regulations.

3.4 PROTECTION:

A. Protect finished work until fully cured in accordance with manufacturer’s recommendations.

END OF SECTION 033600
SECTION 034100

PRECAST CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Precast concrete sanitary sewer manholes. Manhole bases may be round or square.
2. Precast concrete for lift stations including the valve vault.

1.2 REFERENCES

A. ASME B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings
B. ASTM A 307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile
C. ASTM A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
D. ASTM C 270 - Standard Specification for Mortar for Unit Masonry
E. ASTM C 443 - Standard Specification for Joints for Circular Concrete Sewer and Culvert, Using Rubber Gasket
F. ASTM C 478 - Standard Specification for Precast Reinforced Concrete Manhole Sections
G. ASTM C 890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
H. ASTM C 913 – Standard Specifications for Precast Concrete Water and Wastewater Structures
I. ASTM C 923 - Standard Specifications for Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes
K. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soil
1.3 SUBMITTALS

A. Submit manufacturer's data and details of following items for approval:

1. Shop drawings of manhole sections, base units and construction details, including reinforcement, jointing methods, materials and dimensions.

2. Summary of criteria used in manhole design including, as minimum, material properties, loadings, load combinations, and dimensions assumed. Include certification from manufacturer that precast manhole design is in full accordance with ASTM C 478 and/or ASTM C 890 and design criteria as established in Paragraph 2.01E of this Specification.

3. Frames, grates, rings, and covers

4. Materials to be used in fabricating drop connections

5. Materials to be used for pipe connections at manhole walls

6. Materials to be used for stubs and stub plugs, if required

7. Materials and procedures for corrosion-resistant liner and coatings, if required.

8. Plugs to be used for sanitary sewer hydrostatic testing

9. Manufacturer's data for pre-mix (bag) concrete, if used for channel inverts and benches

B. Seal submittal drawings by Professional Engineer registered in State of Texas.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide manhole sections, base sections, and related components conforming to ASTM C478. Provide base riser section with integral floors, unless shown otherwise. Provide adjustment rings which are standard components of manufacturer of manhole sections. Mark date of manufacture and name or trademark of manufacturer on inside of barrel.

B. Construct barrels for precast manholes from standard reinforced concrete manhole sections of diameter indicated on Drawings. Use various lengths of manhole sections in combination to provide correct height with fewest joints. Design wall sections for depth and loading conditions in Paragraph 2.01 E, with minimum thickness of 5 inches. Base section shall have minimum thickness of 12 inches under invert.

C. Provide tops to support cast iron casting meeting AASHTO M-306 Section 5 loading, and receive manhole frame & covers, as indicated on Drawings.
D. Where manholes larger than 48-inch diameter are indicated on Drawings, provide precast base sections with flat slab top precast sections used to transition to 48-inch diameter manhole access riser sections. Transition can be concentric or eccentric unless otherwise shown on Drawings. Locate transition to provide minimum of 7-foot head clearance from base to underside of transition unless otherwise approved by Project Manager.

E. Design Loading Criteria: Manhole walls, transition slabs, cone tops, and manhole base slab shall be designed, by manufacturer, to requirements of ASTM C 478, ASTM C 890 and/or ASTM C 913 for depth as shown on Drawings and to resist following loads.

1. AASHTO M-306  H-20 / HS-20 design live loading loads as referred to in AASHTO M-306 applied to manhole cover and transmitted down to transition and base slabs

2. Unit soil weight of 120 pcf located above portions of manhole, including base slab projections

3. Lateral soil pressure based on saturated soil conditions producing an at-rest equivalent fluid pressure of 100 pcf

4. Internal liquid pressure based on unit weight of 63 pcf

5. Dead load of manhole sections fully supported by transition and base slabs

F. Design: Manhole walls, transition slabs, cone tops, and manhole base slab shall be designed according to requirements of ASTM C 478, ASTM C 890 and/or ASTM C 913 and following:

1. Design additional reinforcing steel to transfer stresses at openings.

2. Wall loading conditions:
   a. Saturated soil pressure acting on empty manhole
   b. Manhole filled with liquid to a halfway depth as measured from invert to cover, with no balancing external soil pressure

2. Minimum clear distance between two wall penetrations shall be 12 inches or half diameter of smaller penetration, whichever is greater

G. Provide joints between sections with askets conforming to ASTM C 443 and/or ASTM C- 990.

H. When base is cast monolithic with portion of vertical section, extend reinforcing in vertical section into base.

I. Precast Concrete Base: Suitable cutouts or holes to receive pipe and connections. Lowest edge of holes or cutouts: For water line manhole, no less than 6 inches above inside surface of floor of base.
2.2 CONCRETE

A. Conform to requirements of Section 033000 – Cast-In-Place Concrete.

B. Channel Inverts: Use 5 sack premix (bag) concrete or Class A concrete for inverts not integrally formed with manhole base, with minimum compressive strength of 4000 psi.

C. Cement Stabilized Sand Foundation: Provide cement stabilized sand foundation under base section in lieu of foundation slab, as shown on Drawings.

D. Concrete Foundation: Provide Class A concrete with minimum compressive strength of 4000 psi for concrete foundation slab under manhole base section where indicated on Drawings.

2.3 REINFORCING STEEL

A. Conform to requirements of Section 032000 – Concrete Reinforcement.

2.4 DROP CONNECTIONS AND STUBS

A. Provide drop connections and stubs conforming to same pipe material requirements used in main pipe, unless otherwise indicated on Drawings.

2.5 PIPE CONNECTIONS TO MANHOLE

A. Sanitary Sewers

1. Provide resilient connectors conforming to requirements of ASTM C 923. Use the following materials for metallic mechanical devices as defined in ASTM C 923:
   a. External clamps: Type 304 stainless steel
   b. Internal, expandable clamps on standard manholes: Type 304 stainless steel, 11 gauge minimum.
   c. Internal, expandable clamps on corrosion-resistant manholes:
      1) Type 316 stainless steel, 11 gauge minimum
      2) Type 304 stainless steel, 11 gauge minimum, coated with minimum 16 mil fusion-bonded epoxy conforming to AWWA C 213

2. Where rigid joints between pipe and cast-in-place manhole base are specified or shown on Drawings, provide polyethylene-isoprene water-stop meeting physical property requirements of ASTM C 923, such as Press-Seal WS Series, or approved equal.
2.6 SEALANT MATERIALS

A. Sealing material between precast concrete adjustment ring and manhole, between each adjustment ring, and between adjustment ring and manhole cover frame shall be a hydrophilic elastic sealant, which adheres to both concrete and metal, or approved equal.

B. Provide approved external sealing material from Canusa Wrapid Seal manhole encapsulation system, or approved equal.

C. Provide Butyl Sealant: Provide Press-Seal EZ Stick, or equal, for HDPE rings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that lines and grades are correct.

B. Determine if subgrade, when scarified and recompacted, can be compacted to 95 percent of maximum Standard Proctor Density, at ±3% optimum moisture content according to ASTM D 698 prior to placement of foundation material and base section. If it does not meet the moisture-density requirement, condition the subgrade until the required moisture-density requirement is met or treat as an unstable subgrade.

C. Do not build manholes in ditches, swales, or drainage paths unless approved by Engineer.

3.2 PLACEMENT

A. Install precast manholes to conform to locations and dimensions shown on Drawings.

B. Place sanitary and storm manholes at points of change in alignment, grade, size, pipe intersections, and end of sewer unless otherwise shown on Drawings.

3.3 MANHOLE BASE SECTIONS AND FOUNDATIONS

A. Place precast base on 12 inch thick (minimum) foundation of crushed stone wrapped in filter fabric, cement stabilized sand, or concrete foundation slab. Compact cement-sand in accordance with plans.
B. Unstable Subgrade Treatment: When unstable subgrade is encountered, notify Project Manager for examination of subgrade to determine if subgrade has heaved upwards after being excavated. When heaving has not occurred, over-excavate subgrade to allow for 24-inch-thick layer of crushed stone wrapped in filter fabric as foundation material under manhole base. When there is evidence of heaving, provide pile-supported concrete foundation, as detailed on Drawings, under manhole base.

C. For manholes located over large diameter water lines, place precast base on a foundation of cement stabilized sand extending from bottom of manhole to bottom of trench. Manhole base is to be a minimum of 12-inches above water line.

3.4 PRECAST MANHOLE SECTIONS

A. Install sections, joints, and gaskets in accordance with manufacturer's printed recommendations.

B. Install precast adjustment rings above tops of cones or flat-top sections as required to adjust finished elevation and to support manhole frame.

C. Seal any lifting holes with non-shrink grout.

D. Where PVC liners are required, seal joints between sections in accordance with manufacturer’s recommendations.

E. Place at least two precast concrete grade rings with thickness of 12 inches or less, under casting.

3.5 PIPE CONNECTIONS AT MANHOLES

A. Install approved resilient connectors at each pipe entering and exiting manholes in accordance with manufacturer’s instructions.

1. Where smooth exterior pipes, i.e. steel, ductile iron or PVC pipes are connected to manhole base or barrel, space between pipe and manhole wall shall be sealed with an assembly consisting of rubber gaskets or links mechanically compressed to form watertight. Assemblies: “Press-Wedge,” “Res-Seal,” “Thunderline Link-Seals,” or approved equal. See Drawings for placement of assembly in manhole sections.

2. When connecting concrete or cement mortar coated steel pipes, or as an option for connecting smooth exterior pipes to manhole base or barrel, space between pipe and manhole wall may be sealed with an assembly consisting of stainless steel power sleeve, stainless steel take-up clamp and rubber gasket. Take-up clamp: Minimum of 9/16 inch wide. Provide PSX positive seal gasket system by Press-Seal Gasket Corporation or approved equal.
B. Install approved resilient connectors at each flexible (hdpe or cmp) pipe connection as per ASTM C-923 and/or ASTM F 2510 to a concrete manhole.

C. Ensure no concrete, cement stabilized sand, fill, or other rigid material is allowed to enter space between pipe and edge of wall opening at and around resilient connector on either interior or exterior of manhole. If necessary, fill space with compressible material to ensure full flexibility provided by resilient connector.

D. Where new manhole is constructed on existing sewer, rigid joint pipe may be used. Install waterstop gasket around existing pipe at center of cast-in-place wall. Join ends of split waterstop material at pipe springline using an adhesive recommended and supplied by waterstop manufacturer.

E. Test connection for watertight seal before backfilling.

3.6 INVERTS FOR SANITARY SEWERS

A. Construct invert channels to provide smooth flow transition waterway with no disruption of flow at pipe-manhole connections. Conform to following criteria:

1. Slope of invert bench: 1 inch per foot minimum; 1-1/2 inches per foot maximum

2. Depth of bench to invert shall be at least equal to the largest pipe diameter.

3. Invert slope through manhole: 0.10 foot drop across manhole with smooth transition of invert through manhole, unless otherwise indicated on Drawings.

B. Form invert channels with concrete if not integral with manhole base section. For direction changes of mains, construct channels tangent to mains with maximum possible radius of curvature. Provide curves for side inlets and smooth invert fillets for flow transition between pipe inverts.

3.7 DROP CONNECTIONS FOR SANITARY SEWERS

A. Backfill drop assembly with crushed stone wrapped in filter fabric, cement stabilized sand, or Class A concrete to form solid mass. Extend cement stabilized sand or concrete encasement minimum of 4 inches outside bells.

B. Install drop connection when sewer line enters manhole higher than 24 inches above invert of manhole.
3.8 MANHOLE FRAME AND ADJUSTMENT RINGS

A. Combine precast concrete or HDPE adjustment rings so elevation of installed casting cover matches pavement surface. Seal between concrete adjustment ring and precast top section with non-shrink grout; do not use mortar between adjustment rings. Apply latex-based bonding agent to precast concrete surfaces joined with non-shrink grout. Set cast iron frame on adjustment ring in bed of approved sealant material. Install sealant bed consisting of two beads of sealant, each bead having minimum dimensions of 1/2-inch and 1/2-inch wide.

B. Wrap manhole frame and adjustment rings with external sealing material, minimum 3 inches beyond joint between ring and frame and adjustment rings and precast section.

C. For manholes in unpaved areas, set top of frame minimum of 6 inches above existing ground line unless otherwise indicated on Drawings. In unpaved areas, encase manhole frame in mortar or non-shrink grout placed flush with face of manhole ring and top edge of frame. Provide rounded corner around perimeter.

3.9 BACKFILL

A. Provide embedment zone backfill material, as specified for adjacent utilities, from manhole foundation up to an elevation 12 inches over each pipe connected to manhole. Provide trench zone backfill, as specified for adjacent utilities, above embedment zone backfill.

B. Where rigid joints are used for connecting existing sewers to manhole, backfill under existing sewer up to springline of pipe with Class B concrete or flowable fill.

C. In unpaved areas, provide positive drainage away from manhole frame to natural grade.

END OF SECTION 034100
SECTION 042200
CONCRETE MASONRY UNIT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including TPWD’S Uniform General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Concrete masonry units.
   2. Concrete masonry unit veneer.
   3. Mortar and grout.
   4. Steel reinforcing bars.
   5. Masonry joint reinforcement.
   6. Ties and anchors.
   7. Miscellaneous masonry accessories.

B. Related Sections:
   1. Section 033000 "Cast-in-Place Concrete" for adjacent concrete construction.

1.3 DEFINITIONS
A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS
A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.

   1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602, OR.

1.5 PRECONSTRUCTION TESTING
A. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
1. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.
3. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019.

1.6 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: For the following:
   1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
   2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.

1.7 INFORMATIONAL SUBMITTALS
A. Material Certificates: For each type and size of the following:
   1. Masonry units.
      a. Include material test reports substantiating compliance with requirements.
      b. For masonry units, include data and calculations establishing average net-area compressive strength of units.
   2. Cementitious materials. Include brand, type, and name of manufacturer.
   3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
   4. Grout mixes. Include description of type and proportions of ingredients.
   5. Reinforcing bars.
   7. Anchors, ties, and metal accessories.
B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
   1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
   2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

1.8 QUALITY ASSURANCE
A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.
B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

D. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

E. Pre-installation Conference: Conduct conference at project site, if required.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.10 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

   1. Extend cover a minimum of 24 inches (600 mm) down both sides of walls and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

   1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.

   2. Protect sills, ledges, and projections from mortar droppings.

   3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.

   4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than 7 days after completing cleaning.


PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

2.2 CONCRETE MASONRY UNITS

A. Basis of Design: Subject to compliance with requirements. Standard color or comparable product by, but not limited to, one of the following:

1. (Basis of Design) “Boral Concrete Products”
2. “Westbrook Concrete Block” in “SF-179”
3. “AMCON Concrete Products” in “704 Coral”
4. “Capitol Products” in “250 Silver Splitface”

B. Textures: Provide textures indicated and as follows, with exposed surfaces as shown in drawings.

1. 4x8x16 in ground face both sides
2. 4x8x16 veneer in split face with “3-score”
3. 4x8x16 veneer in ground face with “3-score”
4. 8x8x16 in ground face both sides
5. 8x8x16 in split face with “3-score” at exterior face and ground face at interior
6. 8x8x16 in ground face with “3-score” at exterior face and ground face at interior

C. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide manufacturer standard L-Corner 4x8x16 as shown in drawings.
3. CMU cap unit per drawing detail 9/A500

D. CMUs: Comply with ASTM C 90.

1. Minimum F’m=2500 psi.
2. Density Classification: Normal weight.
3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
E. Color:
   1. Boral Concrete Products - White Limestone color
   2. Westbrook Concrete Block - CMU color
   3. AMCON Concrete Products – CMU color

2.3 MORTAR AND GROUT MATERIALS

A. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

B. Aggregate for Mortar: ASTM C 144.
   1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
   2. For joints less than 1/4 inch (6 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.

C. Aggregate for Grout: ASTM C 404.

D. Water: Potable.

2.4 REINFORCEMENT

A. Epoxy-Coated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420) deformed bars, with ASTM A 775/A 775M bendable epoxy coating, with less than 2 percent damaged coating in each 12-inch bar length.

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.
   1. Interior Walls: Stainless steel, Type 316.
   2. Wire Size for Side Rods: 0.148-inch (3.77-mm) diameter.
   3. Wire Size for Cross Rods: 0.148-inch (3.77-mm) diameter.
   4. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.
   5. Provide in lengths of not less than 10 feet (3 m), with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods.

2.5 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.
   1. Stainless-Steel Wire: ASTM A 580/A 580M, Type 316.
   2. Stainless-Steel Sheet: ASTM A 666, Type 316.
   3. Stainless-Steel Bars: ASTM A 276 or ASTM A 666, Type 316.

B. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.109-inch-(2.78-mm-) thick, stainless-steel sheet.

2. Tie Section: Adjustable Slotted Stud tied, attached to stud sized to extend within 1 inch (25 mm) of masonry face, made from 0.25-inch-(6.35-mm-) diameter, stainless-steel wire.

3. Corrugated Metal Ties: Metal strips not less than 7/8 inch (22 mm) wide with corrugations having a wavelength of 0.3 to 0.5 inch (7.6 to 12.7 mm) and an amplitude of 0.06 to 0.10 inch (1.5 to 2.5 mm) made from 0.109-inch-(2.78-mm-) thick, stainless-steel sheet with dovetail tabs for inserting into dovetail slots in concrete and sized to extend to within 1 inch (25 mm) of masonry face.

C. For Stud wall construction provide Adjustable Slotted stud ties (type I) with insulation support, manufacturer from 16 gauge (1.61mm) stainless steel metal conforming to ASTM Standard A570, the length can vary different stud widths, insulation and gypsum sheathing thickness, provide insulation support to reduce thermal bridging.

D. Rigid Anchors: Fabricate from steel bars bent to configuration indicated.

1. Corrosion Protection: Epoxy coating 0.020 inch (0.51 mm) thick.

2.6 MISCELLANEOUS ANCHORS

A. Post installed Anchors: chemical anchors.

1. Load Capacity: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.


2.7 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from urethane or PVC.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch (3.77-mm) stainless steel wire. Provide units designed for number of bars indicated.

E. Weep/Vent Products: Use one of the following unless otherwise indicated:
1. Wicking Material: Absorbent rope, made from UV-resistant synthetic fiber, 1/4 to 3/8 inch in diameter, in length required to produce 2-inch exposure on exterior and 18 inches in cavity. Use only for weeps.


4. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.

5. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from manufacturer's standard.

6. Vinyl Weep Hole/Vent: Units made from flexible PVC, designed to fit into a head joint and consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units, and a top flap to keep mortar out of the head joint; in color selected by Architect.

F. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Configuration: Provide one of the following:
   a. Strips, full depth of cavity and 10 inches high, with dovetail-shaped notches 7 inches deep that prevent clogging with mortar droppings.
   b. Strips, not less than 3/4 inch 1-1/2 inches thick and 10 inches high, with dimpled surface designed to catch mortar droppings and prevent weep holes from clogging with mortar.
   c. Sheets or strips, full depth of cavity and installed to full height of cavity.
   d. Sheets or strips not less than 1 inch thick and installed to full height of cavity with additional strips 4 inches high at weep holes and thick enough to fill entire depth of cavity and prevent weep holes from clogging with mortar.

2.8 Mortar and Grout Mixes

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.

2. Use portland cement-lime mortar unless otherwise indicated.

3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
1. For reinforced masonry, use Type S.

D. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2500 psi (14 MPa).
3. Provide grout with a slump of 8 to 11 inches (203 to 279 mm) as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

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

3.2 INSTALLATION, GENERAL

A. Build chases and recesses to accommodate items specified in this and other Sections.

B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch (12 mm) or minus 1/4 inch (6 mm).
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (9 mm) or minus 1/4 inch (6 mm).
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm).

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in stacked bond; do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs. Follow drawings for preferred alternating texture layout.

C. Bond Pattern for Chimney wall in Group Recreational Hall: Lay masonry in running bond; do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

D. Lay concealed masonry with all units in a wythe in stacked bond or bonded by lapping not less than 4-inches (100-mm). Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
E. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar before laying fresh masonry.

F. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

G. Fill space between door frames and masonry solidly with mortar unless otherwise indicated.

H. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

I. Fill cores in hollow CMUs with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

J. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
   1. Install compressible filler in joint between top of partition and underside of structure above.
   2. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:
   1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
   2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
   3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
   4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.6 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).
   1. Space reinforcement not more than 16 inches (406 mm) o.c.
   2. Space reinforcement not more than 8 inches (203 mm) o.c. in foundation walls and parapet walls.
   3. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings in addition to continuous reinforcement.
B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:

1. Provide an open space not less than 1/2 inch (13 mm) wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.

2. Anchor masonry with anchors embedded in masonry joints and attached to structure.

3. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (915 mm) o.c. horizontally.

3.8 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using one of the following methods:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.

2. Install preformed control-joint gaskets designed to fit standard sash block.

3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.

4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

3.9 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.

2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
   1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
   2. Limit height of vertical grout pours to not more than 60 inches (1520 mm).

3.10 FIELD QUALITY CONTROL

A. Inspections: Level 1 special inspections according to the "International Building Code."
   1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
   2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
   3. Place grout only after inspectors have verified proportions of site-prepared grout.

B. Testing Prior to Construction: One set of tests.

C. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

D. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for compressive strength.

E. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

3.11 SPECIAL INSPECTION

A. Special inspection and test of masonry construction shall be performed in accordance with IBC section 1705.4

3.12 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.

3. Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.

4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.

5. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.13 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

   1. Crush masonry waste to less than 4 inches (100 mm) in each dimension.

   2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."

   3. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042200
SECTION 045100

FLUE LINER MASONRY

PART 1-GENERAL:

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION

The requirements for flue liner that may be used in masonry fireplace construction.

1.3 SUBMITTALS

A. CERTIFICATIONS: Submit certifications that all flue liner will meet or exceed designated specifications.

B. QUALIFICATIONS OF INSTALLER:

1. Shall have a minimum of five years’ experience installing masonry fireplaces.

2. Installer shall submit for approval, a list of projects similar in nature and size that establishes his/her ability to complete this project. A resume for the project-superintendent should be submitted to establish his/her ability to complete the project. If for any reason, the qualifications are not acceptable, work shall not commence until an acceptable installer is found.

1.4 REFERENCE

A. ASTM C315-02 - Standard Specification for Clay Flue Liners


D. ASTM C1283-02 - Standard Practice for Installing Clay Flue Lining.


H. ASTM C144- Specification for Aggregate for Masonry.

1.5 PRODUCT HANDLING, STORAGE AND DELIVERY

A. Storage at job site.

B. Units shall stay in their original packing material until ready for use.

C. Crates/pallets shall not be stacked, and shall remain in upright position.

D. Store on firm, level and smooth surface, protected from weather to prevent staining.

1.6 JOB CONDITIONS

A. Cold Weather: Perform work in accordance with ACI 530.1 current edition.

B. Hot Weather: Perform work in accordance with ACI 530.1 current edition.

C. At the end of each workday, or during rainy weather, cover masonry work exposed to weather with waterproof coverage and securely anchor as necessary

PART 2-PRODUCTS:

2.1 MATERIALS

A. Basis of design; Superior Clay Corporation, Clay flue liners

   1. Acceptable manufacturer
      a. Logan Clay Products Company
      b. Sandkuhl Clay Works, Inc.
      c. Mission Clay Products

B. Quality Control

   Chimney pots shall conform to the physical requirements listed below as preformed in accordance with ASTM Specifications.

<table>
<thead>
<tr>
<th>Test average (based on 5 samples)</th>
<th>Method</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absorption (5 hour boil) - 8%</td>
<td>ASTM-C301</td>
<td>ASTM- C315</td>
</tr>
<tr>
<td>Freeze/Thaw Resistance</td>
<td>ASTM C67</td>
<td>ASTM- C315</td>
</tr>
<tr>
<td>Acid Resistance &lt; .25%</td>
<td>ASTM- C301</td>
<td>ASTM- C315</td>
</tr>
</tbody>
</table>

C. Dimension Tolerance

   1. Variation in dimensions of round Chimney Pots shall not exceed those shown in ASTM - C315, Table 3.
   2. Overall height variation not to exceed +/- 1/4 inch per foot.

D. Mortars

   1. Installer should use the proper refractory mortar. Read and follow mortar use instructions.
PART 3-EXECUTION:

3.1 INSTALLATION GENERAL

A. Install plumb

B. Flue liner constructed in accordance with ASTM C1283-02, or approved alternate.

C. All anchors shall be either stainless steel or non-corrosive metal.

3.2 CUTTING AND FITTING

A. If necessary, any cutting or drilling done at job shall be done using a diamond blade or diamond tip drill, while applying a steady stream of cooling water.
SECTION 045400

FIRE BRICK

PART 1-GENERAL:

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION

The requirements for fire brick that may be used in fireplace construction.

1.3 SUBMITTALS

A. SAMPLES: Five individual samples of each fire brick color and/or texture showing normal and extreme variations in color or texture.

B. CERTIFICATIONS: Submit certifications that all fire brick will meet or exceed designated specifications.

C. QUALIFICATIONS OF INSTALLER:

1. Shall have a minimum of five years experience installing clay pavers.
2. Installer shall submit for approval, a list of projects similar in nature and size that establishes his/her ability to complete this project. A resume for the project-superintendent should be submitted to establish his/her ability to complete the project. If for any reason, the qualifications are not acceptable, work shall not commence until an acceptable installer is found.

PART 2-PRODUCTS:

2.1 MATERIALS

A. Basis of design; Whitacre-Greer, W-G Low-Duty Firebrick Red, 1400 S. Mahoning Ave., Alliance, OH 44601. Supplied by Upchruch Kimbrough Co. 713-957-1520 7501 Westview Houston Texas 77055.

1. Acceptable manufacturer
   a. Superior Clay Corporation
   b. BNZ Materials, Inc.
   c. ClayMex

B. Fire Brick may be square edge without lugs. Finish may be smooth or textured.

C. Fire Brick in Fireplace Construction:

1. Size or other specified size as per ASTM C 1271 Low Duty.
PART 3-EXECUTION:

3.1 ALLOWABLE TOLERANCES

A. Colors within a given shipment of firebrick will vary slightly due to subtle changes in clay composition and kiln firing temperature. Installer should blend firebrick to evenly distribute any color variations.

3.2 JOB SITE TREATMENT

A. Firebrick should be transported and stored, both at the supply yard and on the jobsite, under cover in a clean and dry environment. Firebrick is highly absorbent and moisture held in it for an extended period of time may cause the appearance of mold or otherwise affect their quality.

3.3 INSTALLATION

A. Firebrick installations should be thoroughly dry prior to use. Gradual heating will limit the possibility of damage due to thermal shock. Air movement, room heat, or a small fire may accomplish thorough drying. A large fire constructed in a cold or damp firebox is discouraged and may be harmful to the firebrick and structure.

B. Installer should use the proper refractory mortar. Read and follow mortar use instructions.

3.4 EFFLORESCENCE

A. Firebrick does not cause efflorescence. Efflorescence appearing on firebrick or in a firebox is usually a result of moisture in the structure escaping through the firebrick. Protecting the structure, including masonry above and behind the firebox, from the elements before and during construction will help eliminate the likelihood of efflorescence. If efflorescence does appear, eliminate the source of moisture, dry out the structure with air movement, room heat or a small fire, and brush off any remaining efflorescence.

END OF SECTION 045400
SECTION 051200

STRUCTURAL STEEL

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 5 Specification Sections, apply to this sections.

1.2 SECTION INCLUDES

A. Fabrication and erection of structural steel and miscellaneous steel items, as shown on the drawings.

1.3 REFERENCES


B. AISC’s Manual for Steel Construction (Fourteenth Edition)

C. ASTM A 6 (ASTM A 6M) "Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use."

D. Research Council on Structural Connections’ (RCSC) "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

E. ASTM A36 - Structural Steel, Miscellaneous Sections

F. ASTM A992- Structural Steel, Wide Flange Sections

G. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

H. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products


J. ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

K. ASTM A194  Carbon Alloy Steel for Nuts for Bolts for High Pressure and High Temperature Service.

L. ASTM A283 - Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes, and Bars.

M. ASTM A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
N. ASTM A325 - High Strength Bolts for Structural Steel Joints.

O. ASTM A384 - Standard Recommended Practice for Safeguarding Against Warpage and Distortion during Hot-Dip Galvanizing of Steel Assemblies.

P. ASTM A385 - Standard Recommended Practice for Providing High Quality Zinc Coatings (Hot-Dip) on Assembled Products.

Q. ASTM A490 - Heat Treated Steel Structural Bolts, 150 ksi (1035 MPA) Tensile Strength.

R. ASTM A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.

S. ASTM A501 - Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

T. ASTM F436 - Hardened Steel Washers.


V. ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

W. AWS A2.0 - Standard Welding Symbols.

X. AWS D1.1 - Structural Welding Code.


BB. ANSI B18.2 - Heavy Hex Structural Bolts.

CC. ANSI B27.2 - Plain Washers.

DD. ANSI B27.4 - Beveled Washers.

EE. SSPC - Steel Structures Painting Council.

FF. Federal Specifications, Standards of the Occupational Safety and Health Administration (OSHA).

1.4 SUBMITTALS

A. Product Data for each type of product specified to including manufacturer-certified mill test reports. The mill test reports shall reflect the following as a minimum:

1. Specification to which material is produced.
2. Heat number of material.
3. Chemical and physical properties of the material required by the material specification.
4. Destructive and non-destructive test analysis conducted.
5. Grain size or statement that fine grain practice was used, when required.
6. Except as required elsewhere, mill test reports will not be required for such items as miscellaneous hardware, bolts, nuts, washers, rivets, screws, etc.

B. Shop Drawings detailing fabrication of structural steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Indicate welds by standard AWS A2.0 welding symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
3. Indicate type, size, and length of bolts, distinguishing between shop and field bolts.
4. Erection drawings
5. Bills of material - presented on or before the date of steel delivery.
6. Include Shop Drawings signed and sealed by a qualified professional engineer responsible for their preparation. Contractor shall be responsible for the correctness of submittal drawings and for shop and field fits.

1.5 QUALIFICATIONS

A. Prepare Shop Drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State of Texas.

B. Welders' Certificates: Submit data, under provisions TPWD's Uniform General Conditions - Submittal Procedures, certifying welders employed on the Work have AWS qualifications within the previous 12 months.

1.6 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on Drawings. Report any discrepancies to the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 50 percent. Advise TPWD immediately if recycled content requirements will impact project cost, schedule and availability significantly.

B. Steel Shapes and Plate: ASTM A36.

C. Steel Tubing: ASTM A500, Grade B.


F. Galvanizing: Apply zinc coating by the hot-dip process to structural steel for galvanizing to ASTM A123. All exterior steel shall be galvanized.

G. Welding Materials: AWS D1.1; type required for materials being welded.

H. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds and repair painting galvanized steel, with dry film containing not less than 93 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20.

I. Metallic, Shrinkage-Resistant Grout: Premixed, factory-packaged, ferrous aggregate grout, complying with ASTM C 1107, of consistency suitable for application, and a 30-minute working time.

2.2 DESIGN REQUIREMENTS

A. Connections: Connections shall be designed in accordance with the AISC "Specification for Steel Construction". Shop connections shall be assembled by bolting or welding. Field connections shall be bolted, unless otherwise noted on the Drawings.

B. Thickness of steel plates, if not called for on the Drawings, shall be 3/8-inch minimum.

2.3 FABRICATION

A. Fit and shop assemble in largest practical sections for delivery to site.

B. Fabricate items with joints tightly fitted and secured.

C. Connections made with ASTM A307 bolts shall have a plain washer in contact with the element (nut or bolt head) turned in tightening.

D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.4 FINISHES

A. Prepare surfaces to be primed in accordance with SSPC SP 2.

B. Do not prime surfaces in direct contact with concrete or where field welding is required.

C. Galvanize, after completion of welded fabrication, in accordance with ASTM A123, all exterior steel members. Provide minimum 1.25 oz/sq ft galvanized coating.
PART 3 - EXECUTION

3.1 EXAMINATION
A. Before erection proceeds, and with the steel erector present, verify elevations of concrete bearing surfaces and locations of anchorages for compliance with requirements.
B. Beginning of installation means erector accepts existing conditions.

3.2 PREPARATION
A. Clean and strip primed steel items to bare metal where site welding is required.
B. Supply items required to be cast into concrete or embedded in masonry with setting templates, to appropriate sections.

3.3 INSTALLATION
A. Install items plumb and level, accurately fitted, free from distortion or defects.
B. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.
C. Field weld components indicated on shop drawings.
D. Perform field welding in accordance with AWS D1.1.
E. Obtain Engineer’s approval prior to site cutting or making adjustments not scheduled.
F. After erection, prime all welds, abrasions, and surfaces that are not shop primed except for surfaces that are to be in contact with concrete.

3.4 ERECTION
A. Set structural steel accurately in locations and to elevations indicated and according to AISC specifications referenced in this Section.
B. Base and Bearing Plates: Clean concrete bearing surfaces of bond-reducing materials and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
C. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
D. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.
E. Pack grout solidly between bearing surfaces and plates so no voids remain. Finish exposed surfaces, protect installed materials, and allow to properly cure.
F. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

G. Align and adjust various members forming part of complete frame or structure before permanently fastening.

H. Splice members only where indicated.

I. Do not use thermal cutting during erection.

J. Do not enlarge holes in members by burning or by using drift pins. Ream holes that must be enlarged to admit bolts.

3.5 FIELD COATING

A. Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint according to ASTM A 780.
PART 1: GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 5 Specification Sections, apply to these sections.

1.2 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install steel roof deck complete as shown on the drawings and as specified herein.

1.3 RELATED WORK

A. Structural steel is included in Section 051200.

B. Miscellaneous metal is included in Section 055000.

C. Roofing, flashing and insulation are included in Division 7.

D. Field painting, except as specified herein, is included in Division 9.

1.4 SUBMITTALS

A. Shop Drawings: Submit, in accordance with TPWD’s Uniform General Conditions, shop drawings showing:

1. Location and size of all members

2. Projections and openings.

3. Fastener types and layout patterns.

4. Erection marks. Mark each bundle to correspond to the shop drawings.

B. Product Data:

1. Materials, finishes and details of construction of all members

2. Manufacturer's load table including design thickness in inches and section properties, gravity load carrying capability at the span used diaphragm shear capacity and ICC Evaluation Report.

C. Quality Control:

1. Certification from the Steel Deck Institute (SDI) that the steel roof deck is designed in accordance with the SDI.

2. Certification for welders.
3. Written Welding Procedure Specifications (WPS’s) in accordance with AWS D1.3 and SDI requirements for each different welded joint proposed for use whether prequalified or qualified by testing.

4. Electrode manufacturer’s data for actual electrodes proposed. Data shall include manufacturer’s recommended welding parameters for each electrode to be used.

1.5 REFERENCE STANDARDS

A. Steel Deck Institute (SDI)

1. SDI Specifications and Commentary for Steel Roof Deck.

B. American Society for Testing and Materials (ASTM)

1. ASTM A653 - Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron, Alloy-Coated (Galvannealed) by the HotDip Process.


C. American Iron and Steel Institute (AISI)

1. AISI SG-67303-3 — North American Specification for the Design of Cold Formed Steel Structural Members.

D. American Welding Society (AWS)

1. AWS D1.3 — Structural Welding Code — Sheet Steel.

E. International Code Council (ICC)


1.6 QUALITY ASSURANCE

A. Steel roof deck shall conform to the requirements of the SDI.

B. Field welding shall be done by certified welders and shall be in accordance with AWS D1.3 and the AISI.

1. Qualify welders in accordance with AWS D1.3 for each process, position, and joint configuration.

2. WPS’s for each joint type shall indicate proper AWS qualification and be available where welding is performed.

1.7 DELIVERY, STORAGE AND HANDLING

A. Handle material with cranes and derricks. Do not dump material off cars or trucks, or handle in any way likely to cause damage.

B. Store material off the ground with one end elevated to provide drainage. Protect from the elements with a waterproof covering, ventilated to avoid condensation.
C. Material with excessive damage, in the opinion of the Engineer, shall not be incorporated in the work. Remove and replace them with new undamaged material at no additional cost to the Owner.

1.8 PROJECT/SITE REQUIREMENTS

A. Notify the Engineer in writing of any inaccuracies in alignment or level of structural steel and steel joists. Correct inaccuracies before the deck is placed at no additional cost to the Owner.

B. Coordinate sizes and locations of HVAC openings and hatch penetrations with architectural, structural, mechanical, or HVAC drawings, using the approved curb and equipment details.

C. Coordinate size, location and details of all penetrations with the Drawings, other trades and details of approved equipment.

D. Provide reinforcement and miscellaneous framing for all penetrations as shown on the Drawings and as specified herein.

1.9 DEFINITIONS

A. Transverse supports - supports which are perpendicular to the direction of the deck ribs.

B. Longitudinal support - supports which are parallel to the direction of the deck ribs.

PART 2: PRODUCTS

2.1 GENERAL

2.2 MATERIALS

A. Steel roof deck shall conform to the SDI Specifications for Steel Roof Deck and to the AISI.

B. North American Specification for the Design of Cold Formed Steel Structural Members.

C. The depth, type and gage of steel roof deck shall be as shown on the Drawings. Unless otherwise noted, steel roof deck shall be 1-1/2-in deep, 36-in wide, Type B with nestable sidelaps.

D. Steel roof deck and accessories shall be manufactured from steel conforming to ASTM A653, designation SS, Grade 33 or higher.

E. Screws shall be self-drilling, self-tapping hex washer head No. 10 TEKS fasteners with Climaseal coating by Buildex Division, Illinois Tool Works, Itasca, IL.

F. Provide galvanized touch-up to repair damaged surfaces. Use Endupor, zinc-rich coating by Dampney Manufacturing Co., Everett, MA; ZiRP, zinc-rich coating by Duncan Galvanizing Corp., Everett, MA; ZRC Cold Galvanizing Compound by ZRC Chemical Products Co., Division of Norfolk Corp., Quincy, MA, or equal.
PART 3: EXECUTION

3.1 INSTALLATION

A. Install steel roof deck as shown on the Drawings, in accordance with manufacturer’s instructions and in accordance with approved shop drawings. Where possible, extend deck sheets over a minimum of three spans.

B. End laps of steel roof deck shall be at least 2-in long and shall occur over transverse supporting members.

C. Fasten steel roof deck to all interior and exterior transverse supports and at side laps and longitudinal supports. Deck fasteners and fastener spacings shall be as noted in the Steel Deck Schedule and Roof Deck Fastening Standard Details or as indicated on the Roof Framing Drawing.

D. Maintain contact between deck sheets and steel supports while fastening steel roof deck to reduce burn holes at welded connections and to eliminate eccentricities between the connected parts at screwed connections.

E. Welds to supporting members at end laps shall go through both sheets and fuse to the supporting steel.

F. Install screws using tools that prevent fracturing screws, damaging screw heads or stripping threads due to overdriving.

G. Install another screw adjacent to fractured or stripped screws. Remove screws where eccentricities exist between deck sheets and deck sheets and steel supports and install another screw nearby while maintaining contact between the parts to be connected.

H. Coordinate size, location and details of all penetrations with the Drawings, other trades and details of approved equipment. Pipe and conduit openings in the steel roof deck shall be reinforced according to the manufacturer’s recommendation.

I. Cutting and Fitting
   
   a. Cut and fit steel roof deck units and accessories around projections through steel roof deck.
   
   b. Cut openings in steel roof deck true to dimensions using metal saws or drills. Do not use cutting torches.
   
   c. Make cuts neat, square and trim. Make cuts free of burrs.
   
   d. Reinforce opening 6in. and larger but less than 12-in. in greatest dimension with a 24 in.x24 in. flat plate, same gage thickness as deck, centered on the opening.

I. Ridge Plates
   
   a. Weld to top surface of steel roof deck at no more than 12 in on center.
b. Lap end joints not less than 3 in.

2. Closure Strips and Eave Plates

a. Install closure strips at all open uncovered ends and edges of steel roof deck and in voids between deck and other construction.

b. Weld to top surface of steel roof deck at not more than 12-in on center and into position to provide complete deck installation for support of roof insulation.

J. Do not attach suspended ceilings, light fixtures, ducts, piping, conduits or other utilities to steel roof deck.

K. Do not use deck for storage or work platforms until permanently secured into position.

L. Construction loads shall not exceed safe capacity of deck and supporting construction.

3.2 FIELD PAINTING

A. Clean and repair all steel surfaces which have become abraded or where galvanizing has been damaged due to welding and/or erection procedures.

B. Repair abraded or damaged galvanized areas using the touch-up material specified above to produce a dry film thickness of not less than 6 mils. Conduct all repairs of galvanizing in accordance with ASTM A780.

3.3 INSPECTION

A. Field welding will be inspected visually and by non-destructive testing by AWS certified welding inspectors provided by the Owner.

B. The Engineer and the certified welding inspector will inspect steel roof deck in the field for compliance with this Section and the approved shop drawings. The Engineer and the certified welding inspector may reject or require repair or refabrication of any steel roof deck or accessories not meeting these requirements.
SECTION 054000
COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including TPWD's Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes the following:
   1. Interior load-bearing steel-stud walls.
   2. Interior nonload-bearing steel-stud.
   3. Exterior load bearing steel stud walls, columns and beams.

B. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Division 5 Section 055013 - "Metal Fabrications" for masonry shelf angles and connections.
   2. Division 9 Section 092600" - Gypsum Board Assemblies" for gypsum board and nonload-bearing metal-stud framing and ceiling-suspension assemblies.
   3. Division 9 Section 092600 - "Gypsum Board Assemblies" for gypsum sheathing applied to exterior steel framing.

1.3 SUBMITTALS
A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data for each type of cold-formed metal framing, accessory, and product specified.

C. Shop drawings showing layout, spacings, sizes, thicknesses, and types of cold-formed metal framing, fabrication, fastening and anchorage details, including mechanical fasteners. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachments to other units of Work.

D. Mill certificates signed by manufacturers of cold-formed metal framing certifying that their products comply with requirements, including uncoated steel thickness, yield strength, tensile strength, total elongation, and galvanized-coating thickness.

E. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.
F. Qualification data for firms and persons specified in the “Quality Assurance” Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

G. Product test reports from a qualified independent testing agency evidencing compliance with requirements of the following based on comprehensive testing:

1. Expansion anchors.
3. Mechanical fasteners.

H. Research reports or evaluation reports of the model code organization acceptable to authorities having jurisdiction that evidence cold-formed metal framing’s compliance with building code in effect for Project.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has completed cold-formed metal framing similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Testing Agency Qualifications: To qualify for acceptance, an independent testing agency must demonstrate to Architect’s satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.

C. Welding Standards: Comply with applicable provisions of AWS D1.1 “Structural Welding Code--Steel” and AWS D1.3 “Structural Welding Code--Sheet Steel.”

   1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

D. Fire-Test-Response Characteristics: Where fire-resistance-rated assemblies are indicated, provide cold-formed metal framing identical to that tested as part of an assembly for fire resistance per ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

   1. Fire-Resistance Ratings: As indicated by design designations listed in UL “Fire Resistance Directory,” or by Warnock Hersey or another testing and inspecting agency acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering cold-formed metal framing that may be incorporated in the Work include, but are not limited to, the following:

1. Alabama Metal Industries Corp.
2. American Studco, Inc.
3. Angeles Metal Systems.
4. California Metal Systems, Inc.
5. Clark-Cincinnati, Inc.
6. Consolidated Fabricators Corp.
7. Consolidated Systems, Inc.
10. Design Shapes in Steel.
11. Dietrich Industries, Inc.
14. MarinoWare; Div. of Ware Industries, Inc.
15. Studco of Hawaii, Inc.
17. Unimast, Inc.
19. United States Steel.
20. Western Metal Lath Co.

2.2 MATERIALS

A. Galvanized-Steel Sheet: ASTM A 446 (ASTM A 446M), zinc coated according to ASTM A 525 (ASTM A 525M), and as follows:

1. Coating Designation: G 60 (Z 180).

B. Prime-Painted Steel Sheet: ASTM A 570 (ASTM A 570M) or ASTM A 611, cleaned, pretreated, and primed with manufacturer’s baked-on, lead- and chromate-free, rust-inhibitive primer conforming to the performance requirements of FS TT-P-664.

1. Grade: Grade 33 or Grade C, 33,000 psi (230 MPa) minimum yield strength.

2.3 WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs of web depths indicated, with lipped flanges, and complying with the following:

1. Design Uncoated-Steel Thickness: 0.0747 inch (1.90 mm).
2. Flange Width: 1-3/8 inches (35 mm).
3. Web: Unpunched.
B. **Steel Track:** Manufacturer's standard U-shaped steel track, unpunched, of web depths indicated, with straight flanges, and complying with the following:

1. **Design Uncoated-Steel Thickness:** Matching steel studs.
2. **Flange Width:** Manufacturers standard deep flange where indicated, standard flange elsewhere.

### 2.4 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories of the same material and finish used for framing members, with a minimum yield strength of 33,000 psi (230 MPa).

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
5. Deflection track and vertical slide clips.
7. Joist hangers and end closures.
8. Reinforcement plates.

### 2.5 ANCHORS, CLIPS, AND FASTENERS

A. **Steel Shapes and Clips:** ASTM A 36 (ASTM A 36M), zinc coated by the hot-dip process according to ASTM A 123.

B. **Cast-in-Place Anchor Bolts and Studs:** ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); carbon-steel hex-head bolts and studs; carbon-steel nuts; and flat, unhardened-steel washers. Zinc coated by the hot-dip process according to ASTM A 153.

C. **Expansion Anchors:** Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times the design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

D. **Powder-Actuated Anchors:** Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times the design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.

E. **Mechanical Fasteners:** Corrosion-resistant coated, self-drilling, self-threading steel drill screws.

1. **Head Type:** Low-profile head beneath sheathing, manufacturer's standard elsewhere.

F. **Welding Electrodes:** Comply with AWS standards.
2.6 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.

B. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

C. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and a 30-minute working time.

D. Thermal Insulation: ASTM C 665, Type I, unfaced mineral-fiber blankets produced by combining glass or slag fibers with thermosetting resins.

2.7 FABRICATION

A. Fabricate cold-formed metal framing and accessories plumb, square, true to line, and with connections securely fastened, according to manufacturer's recommendations and the requirements of this Section.

1. Fabricate framing assemblies in jig templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed metal framing members by welding. Wire tying of framing members is not permitted.
4. Fasten cold-formed metal framing members by welding or screw fastening, as standard with fabricator. Wire tying of framing members is not permitted.
   a. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   b. Locate mechanical fasteners and install according to cold-framed metal framing manufacturer's instructions with screw penetrating joined members by not less than 3 exposed screw threads.
5. Fasten other materials to cold-formed metal framing by welding, bolting, or screw fastening, according to manufacturer's recommendations.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or distortion.

C. Fabrication Tolerances: Fabricate assemblies to a maximum allowable tolerance variation from plumb, level, and true to line of 1/8 inch in 10 feet (1:960) and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch (3 mm).
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements, including installation tolerances and other conditions affecting performance of cold-formed metal framing. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Before sprayed-on fireproofing is applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed-on fireproofing.

B. After sprayed-on fireproofing has been applied, remove only as much fireproofing as needed to complete installation of cold-formed framing without reducing thickness of fireproofing below that required to obtain fire-resistance rating indicated. Protect remaining fireproofing from damage.

C. Grout bearing surfaces uniform and level to ensure full contact of bearing flanges or track webs on supporting concrete or masonry construction.

3.3 INSTALLATION, GENERAL

A. Cold-formed metal framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed metal framing and accessories plumb, square, true to line, and with connections securely fastened, according to manufacturer's recommendations and the requirements of this Section.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed metal framing members by welding or screw fastening, as standard with fabricator. Wire tying of framing members is not permitted.
   a. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   b. Locate mechanical fasteners and install according to cold-framed metal framing manufacturer's instructions with screw penetrating joined members by not less than 3 exposed screw threads.

C. Install framing members in one-piece lengths, unless splice connections are indicated for track or tension members.

D. Provide temporary bracing and leave in place until framing is permanently stabilized.

E. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.

F. Install insulation in built-up exterior framing members, such as headers, sills, boxed joists, and double studs, inaccessible upon completion of framing work.
G. Fasten reinforcement plate over web penetrations that exceed size of manufacturer's standard punched openings.

H. Erection Tolerances: Install cold-formed metal framing to a maximum allowable tolerance variation from plumb, level, and true to line of 1/8 inch in 10 feet (1:960) and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 LOAD-BEARING WALL INSTALLATION

A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings recommended by the manufacturer, but not greater than the following:

1. Spacing: 24 inches (610 mm) for nail or power-driven anchors.

B. Squarely seat studs against webs of top and bottom tracks. Fasten both flanges of studs to top and bottom track. Space studs as follows:

1. Stud Spacing: As indicated on plans.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Align studs vertically where wall-framing continuity is interrupted by floor framing. Where studs cannot be aligned, continuously reinforce track to transfer loads.

E. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure as indicated.

F. Install headers over wall openings wider than the stud spacing. Locate headers above openings as indicated. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.

1. Frame wall openings with not less than a double stud at each jamb of frame as indicated or required by manufacturer.
2. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.

G. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.

1. Where type of supplementary support is not indicated, comply with stud manufacturer's recommendations and industry standards in each case, considering weight or load resulting from item supported.
H. Install horizontal bridging in stud system, spaced in rows not more than 48 inches (1219 mm) apart. Fasten at each stud intersection.
   1. Bridging: Cold-rolled steel channel, clip angle fastened to webs of punched studs.
   2. Bridging: Flat, steel-sheet straps of width and thickness indicated, fastened to stud flanges.
   3. Bridging: Combination of flat, steel-sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness matching studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.

I. Install steel-sheet diagonal bracing straps to both stud flanges, terminate at and fasten to reinforced top and bottom track. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.

J. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 NONLOAD-BEARING INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.

B. Squarely seat studs against webs of top and bottom tracks. Fasten both flanges of studs to top and bottom track, unless otherwise indicated. Space studs as follows:
   1. Stud Spacing: As indicated on plans.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate steel framing from building structure at locations indicated to prevent transfer of vertical loads while providing lateral support.
   1. Install deflection track and anchor to building structure.
   2. Connect studs with vertical slide clips to continuous angles or supplementary framing anchored to building structure.

E. Install horizontal bridging spaced in rows not more than 48 inches (1219 mm) apart. Fasten at each stud intersection.
   1. Install additional row of horizontal bridging in curtainwall stud beneath deflection track when curtainwall studs are not fastened to an additional top track.
   2. Bridging: Cold-rolled steel channel, clip angle fastened to webs of punched studs.
   3. Bridging: Flat, steel-sheet straps of width and thickness indicated, fastened to stud flanges.
   4. Bridging: Combination of flat, steel-sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness matching studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable curtainwall-framing system.

3.6 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanizing repair paint according to ASTM A 780 and the manufacturer's instructions.

B. Touchup Painting: Wire brush, clean, and paint scarred areas, welds, and rust spots on fabricated and installed prime-painted, cold-formed metal framing.

1. Touchup painted surfaces with same type of shop paint used on adjacent surfaces.

C. Provide final protection and maintain conditions in a manner acceptable to manufacturer and Installer to ensure that cold-formed metal framing is without damage or deterioration at the time of Substantial Completion.

END OF SECTION 054000
PART 1:  GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 5 Specification Sections, apply to this sections.

1.2 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and complete and install fabricated metal items. Furnish all supplementary items necessary for their proper installation.

B. Check Drawings carefully and furnish all anchors, sleeves, bolts, brackets, clips, inserts, angles, loose lintels, tubing, bar stock, plates and other miscellaneous metal not distinctly specified under other Sections but necessary to complete the work.

1.3 RELATED WORK

A. Masonry reinforcement, ties and accessories are included in Division 4.

B. Structural steel and steel deck are included in Division 5.

C. Coating is included in Division 9.

D. Pipe sleeves, wall sleeves and wall castings are included in Division 22.

1.4 SUBMITTALS

A. Submit, in accordance with TPWD’s Uniform General Conditions, shop drawings and product data showing materials of construction and details of installation for:

   1. Shop drawings, showing sizes of members, method of assembly, anchorage and connection to other members.

B. Design Data

   1. Submit manufacturer’s load and deflection tables for grating.

C. Test Reports

   1. Certified copy of mill test reports on each steel, stainless steel, aluminum proposed for use showing the physical properties and chemical analysis.

D. Certificates
1. Certify that welders have been qualified under AWS, within the previous 12 months, to perform the welds required under this Section.

1.05 REFERENCE STANDARDS

A. Aluminum Association (AA) 1.

- M3l: Mechanical Finish, Fine Satin
- C22: Finish, Medium Matte
- A4l: Clear Anodic Coating, Class I

B. American Society for Testing and Materials (ASTM)


11. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.


C. American Iron and Steel Institute (AISI).


D. American Welding Society (AWS)

1. AWS DI.1 - Structural Welding Code - Steel.

2. AWS DI.2 - Structural Welding Code - Aluminum.

3. AWS DI.6 - Structural Welding Code - Stainless Steel

E. Federal Specifications

1. FS-FF-B-575C - Bolts, Hexagonal and Square

F. Occupational Safety and Health Administration (OSHA)

G. International Building Code


H. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.6 QUALITY ASSURANCE

A. The work of this Section shall be completely coordinated with the work of other Sections. Verify, at the site, both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items herein specified.

B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.

C. All welding shall be performed by qualified welders and shall conform to the applicable AWS welding code. Welding of steel shall conform to AWS DI.1 and welding of aluminum shall conform to AWS DI.2 and welding of stainless steel shall conform to AWS DI.6.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver items to be incorporated into the work of other trades in sufficient time to be checked prior to installation.
B. Deliver anchorage devices with setting drawings, templates and instructions for installation.

C. Store delivered items off the ground and protected from dirt and weather.

D. Repair items that have become damaged or corroded to the satisfaction of the Engineer prior to incorporating them into the work.

1.8 PROJECT/SITE REQUIREMENTS

A. Field measurements shall be taken at the site, prior to fabrication of items, to verify or supplement indicated dimensions and to ensure proper fitting of all items.

PART 2: PRODUCTS

2.1 GENERAL

A. The use of manufacturer’s name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

B. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance and manufacturer’s service.

2.2 MATERIALS

A. Unless otherwise noted, materials for miscellaneous metals shall conform to the following standards:

1. Structural Steel  
   ASTM A36

2. Structural Steel Tubing  
   ASTM A500, Grade B ASTM

3. Welded and Seamless Steel Pipe  
   ASTM A501 or ASTM A53 Type E or S, Grade B Schedule 40. Use standard malleable iron fittings, galvanized for exterior work

4. Steel Sheets  
   ASTM A366

5. Gray Iron Castings  
   ASTM A48, Class 35

6. Ductile Iron Castings  
   ASTM A536, Grade 65-45-12

7. Aluminum Extruded Pipe  
   ASTM B428, Alloy 6063 T6

8. Aluminum Extruded Shapes  
   ASTM B221, Alloy 6061 T6

9. Aluminum Sheet and Plate  
   ASTM B209, Alloy 6061 T6

10. Stainless Steel Plates, Sheets, and Structural Shapes
    a. Exterior, Submerged or Industrial Use  
       ASTM A240, Type 316 (Type 316L for...
b. Interior and Architectural Use  
A240, Type 304 ASTM

12. Carbon Steel bolts and Studs  
ASTM A307, Grade A (hot dip galvanized nuts and washers where noted)

13. High Strength Steel Bolts, Nuts and washers  
ASTM A325 (mechanically galvanized per ASTM B695, Class 50, where noted)
  a. Elevated Temperature Exposure  
Type I
  b. General Application  
Type 1 or Type II

14. Galvanizing  
ASTM A123, Zn w/0.05 percent minimum Ni

15. Galvanizing, hardware  
ASTM A 153, Zn w/0.05 percent Minimum Ni

2.3 ANCHORS, BOLTS AND FASTENING DEVICES

A. Anchor bolt material shall be ASTM F 1554 Grade 36 unless otherwise noted.

B. Unless otherwise noted, bolts for the connection of carbon steel or iron shall be steel machine bolts, bolts for the connection of galvanized steel or iron shall be galvanized steel or stainless steel machine bolts; and bolts for the connection of aluminum or stainless steel shall be stainless steel machine bolts.

C. Unless otherwise noted, expansion anchors shall be zinc plated carbon steel wedge type anchors complete with nuts and washers. Type 316 stainless steel wedge type anchors shall be used where they will be submerged or exposed to the weather or where stainless steel wedge type anchors are required. When the length or embedment of the bolt is not noted on the Drawings, provide length sufficient to place the wedge and expansion cone portion of the bolt at least 1-inch behind the concrete reinforcing steel. Expansion anchors shall be Hilti, Kwik-Bolt III; Simpson Strong-Tie Wedge-All; Powers Power-Stud or equal.

D. Adhesive anchors, for fastening to concrete, shall be a two-component pre-proportioned cartridge system containing pre-measured amounts resin and hardener which are mixed and deposited in a screen tube by a dispenser. Anchor assemblies shall consist of an all-thread anchor rod with nut and washer. Adhesive anchors shall be Hilti, HIT HY 200 MAX Injection Adhesive Anchors or equal.

E. Adhesive anchors, for fastening to hollow concrete block or brick, shall be a three-part stud, screen and chemical dispenser anchoring system. Adhesive cartridges shall contain premeasured amounts of resin and hardener which are mixed and deposited in a screen tube by a dispenser. Stud assemblies shall consist of an all-thread anchor rod with nut and washer. Anchors shall be Hilti, HIT HY-20 System or equal.

F. Automatic end welded headed anchor studs shall be flux ended studs made from cold drawn steel, ASTM A108 Grades C-1010 through C-1020. Headed anchor studs shall be Nelson, H4L Headed Concrete Anchors or equal.
G. Machine bolts and nuts shall conform to Federal Specification FF-B-575C. Bolts and nuts shall be hexagon type. Bolts, nuts, screws, washers and related appurtenances shall be Type 316 stainless steel.

H. Toggle bolts shall be Hilti, Toggler Bolt or equal.

2.4 MISCELLANEOUS ALUMINUM

A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.

B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Welding shall be on the unexposed side as much as possible in order to prevent pitting or discoloration of the aluminum exposed surface. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.

C. Miscellaneous aluminum items shall include: beams, angles, closure angles, grates, hatches, floor plates, stop plates, stair nosings and any other miscellaneous aluminum called for on the Drawings and not otherwise specified.

D. Angle frames for hatches, beams, grates, etc., shall be complete with welded strap anchors attached.

E. Aluminum diamond plate and floor plate shall have a minimum thickness of 3/8-in. Frames and supports shall be of aluminum construction. Fastening devices and hardware shall be Type 316 stainless steel. Plates shall have a mill finish.

F. All miscellaneous aluminum shall have a cleaned and degreased mill finish unless otherwise indicated on the Drawings or as specified herein.

2.5 MISCELLANEOUS STEEL

A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.

B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.

C. Miscellaneous steel items shall include: beams, angles, lintels, support brackets, base plates for other
MISCELLANEOUS METAL

than structural steel or equipment, closure angles, bridge crane rails, monorail hoist beams, holdown straps and lugs, door frames, splice plates, sub framing at roof openings and any other miscellaneous steel called for on the Drawings and not otherwise specified.

D. Structural steel angle and channel door frames shall be galvanized. Frames shall be fabricated with not less than three anchors on each jamb.

E. Steel pipe pieces for sleeves, lifting attachments and other functions shall be Schedule 40 pipe unless otherwise shown on the Drawings. Wall and floor sleeves, of steel pipe, shall have welded circumferential steel waterstops at mid-length.

F. Lintels, relief angles or other steel supporting masonry or embedded in masonry shall be galvanized.

G. All steel finish work shall be thoroughly cleaned, by effective means, of all loose mill scale, rust and foreign matter and shall be given one shop coat of primer compatible with the finish coat after fabrication but before shipment. Paint shall be omitted within 3-in of proposed field welds. Paint shall be applied to dry surfaces and shall be thoroughly and evenly spread and well worked into joints and other open spaces.

H. Galvanizing, where required, shall be the hot-dip zinc process after fabrication. Coating shall be not less than 2 oz/sq. ft. of surface.

2.6 CASTINGS

A. Casting shall be of good quality, strong, tough, even-grained, smooth, free from scale, lumps, blisters, sand holes and defects of any kind which render them unfit for the service for which they are intended. Castings shall be thoroughly cleaned and will be subjected to a hammer inspection in the field by the Engineer. All matching surfaces shall be machined to a true plane surface to allow contact surfaces to seat at all points without rocking. Allowances shall be made in the patterns so that the thickness specified shall not be reduced in obtaining finished surfaces. Castings will not be acceptable if the actual weight is less than 95 percent of the theoretical weight computed from dimensions. The Contractor shall provide facilities for weighing castings in the presence of the Engineer.

B. Frames, covers, cast grates and trench drains for structures shall be gray iron castings except as otherwise specified or indicated on the Drawings. Sizes shall be as shown on the Drawings. Covers shall have letters "WATER," "SANITARY SEWER," or "DRAIN," as applicable, embossed on top.

C. Frames and covers for installation in slabs shall be heavy duty, R-6013-R-6099 Series as manufactured by Neenah Foundry Co., or equal.

D. Electrical and telephone manhole and handhole frames and covers [for structures] shall be ductile iron castings. The covers shall be watertight. Covers shall have the word "ELECTRIC," "HIGH VOLTAGE," "LOW VOLTAGE," "SIGNAL," "TELEPHONE," as applicable, embossed on or cast into the top in letters 2-in high. The clear opening shall be 36-in unless otherwise indicated on the Drawings.

E. Trench drains shall be of the length shown on the Drawings.
PART 3 EXECUTION

3.1 INSTALLATION

A. Install all items except those to be embedded in concrete or other masonry which shall be installed under Division 3 and Division 4 respectively. Items to be attached to concrete or masonry after such work is completed shall be installed in accordance with the details shown. Fastening to wood plugs in masonry will not be permitted.

B. Abrasions in the shop primer shall be touched up immediately after erection. Areas left unprimed for welding shall be painted with primer after welding.

C. Zinc coating which has been burned by welding, abraded, or otherwise damaged shall be cleaned and repaired after installation. The damage area shall be thoroughly cleaned by wire brushing and all traces of welding flux and loose or cracked zinc coating removed prior to painting. The cleaned area shall be painted with two coats of zinc oxide-zinc dust paint conforming to the requirements of Military Specifications MIL-P-15145. The paint shall be properly compounded with a suitable vehicle in the ratio of one part zinc oxide to four parts zinc dust by weight.

D. Specialty products shall be installed in accordance with the manufacturer’s recommendations.

E. Expansion bolts shall be checked for tightness a minimum of 24 hours after initial installation.

F. Install adhesive capsule anchors using manufacturer’s recommended drive units and adapters and in compliance with the manufacturer’s recommendations.

G. Headed anchor studs shall be welded in accordance with manufacturer’s recommendations.

H. All railings shall be erected to line and plumb.

I. All steel surfaces that come into contact with exposed concrete or masonry shall receive a protective coating of an approved heavy bitumastic troweling mastic applied in accordance with the manufacturer’s instructions prior to installation.

J. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.

K. Where aluminum contacts masonry or concrete, apply a heavy coat of approved alkali resistant paint to the masonry or concrete.

L. Where aluminum contacts wood, apply two coats of aluminum metal and masonry paint to the wood.

M. Between aluminum gratings, aluminum stair treads, or aluminum handrail brackets and steel supports, insert 1/4-in thick neoprene isolator pads, 85 plus or minus 5 Shore A durometer, sized for full width and length of bracket or support.

END OF SECTION
SECTION 055013
METAL FABRICATIONS

PART 1 - GENERAL

1.1 REFERENCE DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General
   Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply
   to this Section.

1.2 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and
   Division 1 Specification Sections.

B. Shop drawings detailing fabrication and erection of each metal fabrication indicated.
   Include plans, elevations, sections, and details of metal fabrications and their
   connections. Show anchorage and accessory items. Provide templates for anchors and
   bolts specified for installation under other Sections.

1.3 QUALITY ASSURANCE

A. Fabricator Qualifications: Firm experienced in producing metal fabrications similar to
   those indicated for this Project with a record of successful in-service performance, and
   with sufficient production capacity to produce required units without delaying the Work.

B. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding
   Code--Steel."

PART 2 - PRODUCTS

2.1 FERROUS METALS

A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work,
   provide materials selected for their surface flatness, smoothness, and freedom from
   surface blemishes. Do not use materials with exposed pitting, seam marks, roller marks,
   rolled trade names, or roughness.

B. Steel Plates, Shapes, and Bars: ASTM A 36 (ASTM A 36M).
   1. For exterior installations and where indicated, provide tubing with hot-dip
      galvanized coating per ASTM A 53.

C. Steel Pipe: ASTM A 53, standard weight (schedule 40), unless otherwise indicated, or
   another weight required by structural loads.
   1. Black finish, unless otherwise indicated.
   2. Galvanized finish for exterior installations and where indicated.


F. Cast-in-Place Anchors in Concrete: Anchors of type indicated below, fabricated from corrosion-resistant materials capable of sustaining, without failure, the load imposed within a

G. Safety factor of 4, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

2.2 PAINT

A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements of FS TT-P-664, selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

B. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in galvanized steel, with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035 or SSPC-Paint 20.

2.3 FASTENERS

A. General: Provide plated fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating, for exterior use or where built into exterior walls. Select fasteners for the type, grade, and class required.

2.4 GROUT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.5 CONCRETE FILL

A. Concrete Materials and Properties: Comply with requirements of Division 3 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa), unless other strengths are indicated.

2.6 FABRICATION, GENERAL

A. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.
B. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.

C. Ease exposed edges to a radius of approximately 1/32 inch (1 mm), unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

E. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

F. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.7 ROUGH HARDWARE

A. Furnish bent, or otherwise custom-fabricated, bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware items are specified in Division 6 Sections.

B. Fabricate items to sizes, shapes, and dimensions required.

2.8 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports for applications indicated that are not a part of structural steel framework as required to complete the Work.

B. Fabricate units to sizes, shapes, and profiles indicated and required to receive other adjacent construction retained by framing and supports. Fabricate from structural steel shapes, plates, and steel bars of welded construction using mitered joints for field connection. Cut, drill, and tap units to receive hardware, hangers, and similar items.

2.9 FINISHES, GENERAL

A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to applying and designing finishes.

B. Finish metal fabrications after assembly.

2.10 METAL SHIP’S LADDER

A. Provide aluminum ships' ladders where indicated. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.
1. **Basis-of-Design Product:** Subject to compliance with requirements, provide O'Keeffe's Inc.; Model 520 Standard Ship Ladder
   
   a. ACL Industries, Inc.  
   b. Alco-Lite Industrial Products.  
   c. Halliday Products.  
   d. Precision Ladders, LLC.  
   e. Royalite Manufacturing, Inc.  
   f. Thompson Fabricating, LLC.  

2. **Incline:** 60 degree.  
3. **Ship Ladder Treads:** Not less than 1-1/4 inches (32 mm) high, 4-1/8 inch (105 mm) deep, and 2 feet (610 mm) wide. Tread spacing shall be 12 inches (305 mm) on center.  
4. **Handrails:** Aluminum pipe, not less than 1-1/2 inches (38 mm) in diameter with hemispheric end caps.  
5. **Ship Ladder Seismic Bottom Support:** Manufacturer's standard, two isolation bearings per stringer.  
6. **Landing Platform:** 1-1/2 inches (38 mm) or grater, tubular aluminum guard rails and decks of serrated aluminum treads.  

### 2.11 STEEL AND IRON FINISHES

#### A. Galvanizing
   
   For those items indicated for galvanizing, apply zinc coating by the hot-dip process complying with the following requirements:
   
   1. ASTM A 153 for galvanizing iron and steel hardware.  
   2. ASTM A 123 for galvanizing both fabricated and unfabricated iron and steel products made of uncoated rolled, pressed, and forged shapes, plates, bars, and strip 0.0299 inch (0.76 mm) thick or thicker.  

#### B. Preparation for Shop Priming
   
   Prepare uncoated ferrous metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:
   
   1. Exteriors (SSPC Zone 1B): SSPC-SP 6 "Commercial Blast Cleaning."  
   2. Interiors (SSPC Zone 1A): SSPC-SP 3 "Power Tool Cleaning."  

#### C. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes or to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with requirements of SSPC-PA 1 "Paint Application Specification No. 1" for shop painting:
   
   1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installing anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

B. Set sleeves in concrete with tops flush with finish surface elevations. Protect sleeves from water and concrete entry.

3.2 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.

D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop-welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are intended for bolted or screwed field connections.

E. Field Welding: Comply with the following requirements:

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.

3.3 INSTALLING PIPE BOLLARDS

A. Anchor bollards in concrete.

B. Fill bollards solidly with concrete, mounding top surface.
3.4 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of the shop paint on miscellaneous metal is specified in Division 9.

C. For galvanized surfaces, clean welds, bolted connections, and abraded areas, and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION 055013
SECTION 055200
METAL RAILINGS

PART 1 - GENERAL

1.1 SUMMARY
A. Work Results:
   1. Provide exterior galvanized steel handrail systems.

1.2 SUBMITTALS
A. Product Data: Of Manufacturer's product lines for railings assembled from standard components.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Include rated capacities, furnished specialties, and accessories.
B. Shop Drawings:
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Detail fabrication and assembly of handrails.

1.3 INFORMATIONAL SUBMITTALS
A. Qualification Data: For manufacturer and Installer.
B. Sample Warranty: For manufacturer's warranty.
C. Welding Certificates.

1.4 CLOSEOUT SUBMITTALS
A. Cleaning Instructions.

1.5 QUALITY ASSURANCE
A. Manufacturer Qualifications: A railings system manufacturer who is a member in good standing with PCI and AAMA.
1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements: Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Storage and Handling Requirements:
   1. Store and handle materials in accordance with manufacturer’s instructions.
   2. Keep materials in manufacturer’s original, unopened containers and packaging until installation.
   3. Store materials in clean, dry area.
   5. Protect materials and finish during storage, handling, and installation to prevent damage.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of handrail system that fail in materials or workmanship within specified warranty period.

   1. Warranty does not include the failures caused by the following:

      a. Damage caused by faulty installation, or from improper application.
      b. Damage attributable to fire, violent storms, earthquake or other Acts of God, accidents, vandalism, or other casualties, impact of objects, or exposure to atmospheric pollutants or conditions other than natural weather processes.
      c. Damage or discoloration due to misuse, abuse, abrasion (including sand abrasion), and improper storage or to alteration of the material by paints, chemicals, or other substances not recommended for Aluminum Continuous Handrail Products.
      d. Any materials not supplied by railing system manufacturer.
      e. Cost of installation or removal, freight, labor and similar costs.
      f. Any incidental or consequential damages.
      g. Installations where the atmosphere is influenced by bodies of salt water (or other contaminant conditions) must adhere to the railing system manufacturer's cleaning and maintenance guidelines.

   2. Warranty Period: 30-year Limited Warranty from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 HANDRAIL SYSTEM

   A. Products: 1-1/2” outer diameter, rounded, Schedule 40, hot dipped, galvanized steel

      1. Handrail Height: 36 inches.
2.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:
   a. Uniform load of 50 lb/ft. applied in any direction.
   b. Concentrated load of 200 lb applied in any direction.
   c. Uniform and concentrated loads need not be assumed to act concurrently.

B. Regulatory Requirements: Comply with applicable provisions in [the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities.

2.3 ACCESSORIES

A. General: Provide manufacturer’s standard accessories as required for complete railing system as indicated on the drawings and as required to comply with performance requirements.

2.4 FASTENERS

A. General: Type 304 stainless-steel fasteners.

1. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Fasteners for Interconnecting Railing Components:

1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.

D. Post-Installed Anchors: Anchors capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

2.5 MISCELLANEOUS MATERIALS

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

1. Water-Resistant Product: At exterior locations provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

C. Reinforcing: Extrusions and plates as required to comply with performance requirements.

2.6 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage.

B. Cut, drill, and punch pipe aluminum cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Fabricate connections that are exposed to weather in a manner that excludes water. Provide weep holes where water may accumulate.

D. Form Changes in Direction as Follows:

1. By bending to manufacturer's standard radius.

E. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work.

1. Fabricate anchorage devices capable of withstanding loads imposed by railings as required to comply with Performance Requirements.

2. Coordinate anchorage devices with supporting structure.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.

2. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1. Coat, with a heavy coat of bituminous paint, concealed surfaces of aluminum that are in contact with grout, concrete, masonry, wood, or dissimilar metals.

D. Adjust railings before anchoring to ensure matching alignment at abutting joints.

E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.2 RAILING CONNECTIONS

A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

3.3 ATTACHING RAILINGS

A. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

1. Maximum Spacing: 6 feet.

B. Secure railing to building construction as follows:

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and lag bolts.

3.4 ERECTION TOLERANCES

A. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

3.5 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION 055200
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. ADA-Compliant Aluminum Pipe Railings for Handrails.

B. Related Sections:

1. Division 3 Section “Cast-in-Place Concrete”

1.3 PERFORMANCE REQUIREMENTS

A. Design railings, including comprehensive engineering analysis by a qualified licensed professional engineer, using performance requirements and design criteria indicated.

B. In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:

1. Aluminum: The lesser of minimum yield strength divided by 1.65 or minimum ultimate tensile strength divided by 1.95.

C. Structural Performance: Railings shall be ADA-compliant and withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

   a. Uniform load of 50 lbf/ ft. applied in any direction.
   b. Concentrated load of 200 lbf applied in any direction.
   c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

   a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
   b. Infill load and other loads need not be assumed to act concurrently.
D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

E. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Manufacturer’s product lines of mechanically connected railings.
   2. Railing brackets.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples for Initial Selection: For products involving selection of color, texture, or design, including mechanical finishes on aluminum.

D. Samples for Verification: For each type of exposed finish required.
   1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
   2. Fittings and brackets.
   3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.
      a. Show method of finishing at connecting member’s intersections.

E. Design, structural calculations and analysis data, signed and sealed by the licensed professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of railing from single source from single manufacturer.

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

A. Field Measurements: Verify actual locations of stairs and other construction contiguous with metal fabrications by field measurements before fabrication.

1.8 COORDINATION AND SCHEDULING

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers’ written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Aluminum Pipe Railings:
   a. ATR Technologies, Inc.
   b. Blum, Julius & Co., Inc.
   c. Braun, J. G., Company; a division of the Wagner Companies.
   d. CraneVeyor Corp.
   e. Hollaender Manufacturing Company.
   f. Kee Industrial Products, Inc.
   g. Moultrie Manufacturing Company.
   h. Pisor Industries, Inc.
   i. Sterling Dula Architectural Products, Inc.; Div. of Kane Manufacturing.
   j. Superior Aluminum Products, Inc.
   k. Thompson Fabricating, LLC.
   l. Tri Tech, Inc.
   m. Tubular Specialties Manufacturing, Inc.
   n. Tuttle Railing Systems; Div. of Tuttle Aluminum & Bronze, Inc.
   o. Wagner, R & B, Inc.; a division of the Wagner Companies.

2.2 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

2.3 ALUMINUM

A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.

B. Extruded Tubing: ASTM B 221, Alloy 6063-T5, 1-1/2” outer diameter, unless otherwise indicated.


1. Provide Standard Weight (Schedule 40) pipe, 1-1/2” outer diameter, unless otherwise indicated.

D. Drawn Seamless Tubing: ASTM B 210, Alloy 6063-T832, 1-1/2” outer diameter, unless otherwise indicated.


H. Cane detection brakes and rail: Lido Design bracket and rail kit LB-44-FR006/2

I. Finish

1. Comfort Station: #4 Brushed Aluminum for pipe railing.
2. Group Recreation Hall: Prefinished with three coats of fluorocarbon coating; color as noted in the drawings.
3. Group Recreation Hall: Cane detection bar and brackets Satin Brushed Stainless steel 5’ Bar and Brackets

2.4 FASTENERS

A. General: Provide the following:

1. Aluminum Railings: Type 316 stainless-steel fasteners.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Fasteners for Interconnecting Railing Components:

1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
2. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.

3. Provide tamper-resistant flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.


2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For aluminum railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.


E. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

1. Water-Resistant Product: At exterior locations provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.6 FABRICATION

A. General: Fabricate continuous railings to comply with ADA requirements and design criteria indicated for design loadings, dimensions, member sizes and spacing, details, finish, and anchorage.
B. Top railing shall be 36” above concrete. Bottom railing shall be 4” above nose of risers.

C. Top rail shall extend 12” beyond top and bottom riser before turning down.

D. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

E. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

F. Form work true to line and level with accurate angles and surfaces.

G. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

I. Connections: Fabricate railings with welded connections unless otherwise indicated.

J. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

   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 flux immediately.
   4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

K. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.

L. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

   1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

M. Form changes in direction as follows:

N. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

O. Close exposed ends of railing members with prefabricated end fittings.

P. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
Q. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.

R. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

S. For railing posts set in concrete, provide stainless-steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.

2.7 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

E. The finish for aluminum pipe railing shall be #4 Brushed Aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

C. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

D. Adjust railings before anchoring to ensure matching alignment at abutting joints.

E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.4 ANCHORING POSTS

A. Use metal sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Form or core-drill holes not less than 5 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.

C. Cover anchorage joint with flange of same metal as post, attached to post with set screws.

D. Leave anchorage joint exposed with anchoring material flush with adjacent surface.

E. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:

1. For aluminum pipe railings, attach posts using fittings designed and engineered for this purpose.
3.5 ATTACHING RAILINGS

A. Anchor railing ends at walls with round flanges anchored to wall construction and welded to railing ends.

B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends.

C. Attach railings to wall with wall brackets, except where end flanges are used. Provide brackets with 1-1/2-inch clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

   1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.
   2. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

D. Secure wall brackets and railing end flanges to building construction as follows:

3.6 ADJUSTING AND CLEANING

A. Clean aluminum by washing thoroughly with clean water and soap and rinsing with clean water.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.7 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION 055213
SECTION 057500

DECORATIVE FORMED METAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Closures, trim, and brake metals.
   2. Exterior metal panels.
   3. Exterior window covers.

B. Related Requirements:
   1. Section 076200 "Sheet Metal Flashing and Trim" for items made of formed metal for flashings and trim.
   2. Section 077100 "Roof Specialties" for items made of formed metal for parapets and copings.

1.3 COORDINATION

A. Coordinate installation of anchorages for decorative formed metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver items to Project site in time for installation.

B. Coordinate installation of decorative formed metal with adjacent construction to ensure that wall assemblies, flashings, trim, and joint sealants, are protected against damage from the effects of weather, age, corrosion, and other causes of deterioration.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including finishing materials.

B. Shop Drawings: Show fabrication and installation details for decorative formed metal.
   1. Include plans, elevations, component details, and attachment details.
   2. Indicate materials and profiles of each decorative formed metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.

C. Samples for Initial Selection: For products involving selection of color, texture, or design, including mechanical finishes.
D. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For decorative formed metal elements that house items specified in other Sections. Show dimensions of housed items, including locations of housing penetrations and attachments, and necessary clearances.

B. Qualification Data: For Installer fabricator organic-coating applicator and professional engineer.

C. Mill Certificates: Signed by stainless-steel manufacturers certifying that products furnished comply with requirements.

D. Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For cleaning methods/materials to be included in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing decorative formed metal similar to that indicated for this Project and with a record of successful in-service performance as well as sufficient production capacity to produce required units.

B. Manufacturing Qualifications

1. Obtain sheet and plate material for each system from a single manufacturer to ensure quality of appearance and performance.

2. A qualified firm is one experienced in producing Weathering Steel similar to that indicated for this Project and with a record of at least 3 successful in-service performances with like product on as large or larger scope than project, as well as sufficient production capacity to produce required units.

C. Installer Qualifications: Fabricator of products.

D. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockups for the each type of decorative formed metal.

   a. Size 4 feet by 8 feet long.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver decorative formed metal products wrapped in protective coverings and strapped together in suitable packs or in heavy-duty cartons. Remove protective coverings before they stain or bond to finished surfaces.

B. Store products on elevated platforms in a dry location.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, columns, beams, and other construction contiguous with decorative formed metal by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Decorative formed metal items, including anchors and connections, shall withstand the effects of gravity loads and the following loads and stresses without exceeding the allowable design working stress of materials involved and without exhibiting permanent deformation in any components:

1. Wind Loads on Exterior Items: As indicated on Drawings.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 SHEET METAL

A. General: Fabricate products from sheet metal without pitting, seam marks, roller marks, stains, discolorations, or other imperfections where exposed to view on finished units.

B. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating, either commercial steel or forming steel.

C. Weathering steel sheet: ASTM A606

D. Plates shapes and bars: weathering; ASTM A588

2.3 MISCELLANEOUS MATERIALS

A. Gaskets: As required to seal joints in decorative formed metal and remain weathertight; as recommended in writing by decorative formed metal manufacturer.
1. ASTM D 1056, Type 1, Class A, grade as recommended by gasket manufacturer to obtain seal for application indicated.
2. Closed-cell polyurethane foam, adhesive on two sides, release paper protected.

B. Sealants, Exterior: Elastomeric sealant complying with Section 079200 "Joint Sealants" and as recommended in writing by decorative formed metal manufacturer.

C. Sealants, Interior: Nonsag, paintable sealant complying with Section 079200 "Joint Sealants" and as recommended in writing by decorative formed metal manufacturer.

D. Filler Metal and Electrodes: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded or brazed and as necessary for strength, corrosion resistance, and compatibility in fabricated items.

1. Use filler metals that will match the color of metal being joined and will not cause discoloration.

E. Fasteners: Fabricated from same basic metal and alloy as fastened metal unless otherwise indicated. Do not use metals that are incompatible with materials joined.

1. Provide concealed fasteners for interconnecting decorative formed metal items and for attaching them to other work.
2. Provide tamper-resistant flat-head machine screws for exposed fasteners unless otherwise indicated.

F. Structural Anchors: For applications indicated to comply with certain design loads, provide fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308.

G. Nonstructural Anchors: For applications not indicated to comply with design loads, provide fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308.

H. Anchor Materials:


I. Laminating Adhesive: Adhesive recommended by metal fabricator that will fully bond metal to metal, will prevent telegraphing and oil-canning, and is compatible with substrate and noncombustible after curing.

J. Isolation Coating: Manufacturer's standard epoxy coating.

2.4 FABRICATION, GENERAL

A. Shop Assembly: Preassemble decorative formed metal items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
B. Coordinate dimensions and attachment methods of decorative formed metal items with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.

C. Form metal to profiles indicated, in maximum lengths to minimize joints. Produce flat, flush surfaces without cracking or grain separation at bends. Fold back exposed edges of unsupported sheet metal to form a 1/2-inch- (12-mm-) wide hem on the concealed side, or ease edges to a radius of approximately 1/32 inch (1 mm) and support with concealed stiffeners.

D. Increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as needed to provide surface flatness equivalent to stretcher-leveled standard of flatness and sufficient strength for indicated use.

   1. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.

E. Build in straps, plates, and brackets as needed to support and anchor fabricated items to adjoining construction. Reinforce decorative formed metal items as needed to attach and support other construction.

F. Provide support framing, mounting and attachment clips, splice sleeves, fasteners, and accessories needed to install decorative formed metal items.

G. Where welding is indicated, weld or braze joints and seams continuously. Grind, fill, and dress to produce smooth, flush, exposed surfaces in which joints are not visible after finishing is completed.

   1. Use welding procedures that will blend with and not cause discoloration of metal being joined.

2.5 PANEL FABRICATIONS

A. Clearly mark units for reassembly and coordinated installation.

B. Use connections that maintain structural value of joined pieces.

C. Form Weathering Steel to required shapes and sizes, true to line, and level with true curves and accurate angles and surfaces.

D. Form bent-metal corners to smallest radius reasonable without causing grain separation or otherwise impairing the Work.

E. Fabricate all corners to a spec radius suitable to ensure safety of interacting persons. No sharp edges should exist in finished façade.

F. Form simple and compound curves in bars, pipe, tubing and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required.

G. Cut metals cleanly and accurately using CNC laser cutting to ensure there are high tolerances and no rough areas in fabrication.
H. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.

I. Ledges, crevices and pockets that hold water, water-laden debris, or condensation for an extended period of time shall be avoided. Under such circumstances, corrosion continues in these areas.

J. Visible welds shall color match final Weathering Steel finish and shall be corrosion resistant.

2.6 WEATHERED STEEL PANELS (MTL-4)

A. Manufacturer

1. Basis-of-Design
   a. Dissimilar Metal Design (www.dmd-world.com) pre-weathered sheets “DMD-149”

B. Form panels from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction.

   1. Weathering Steel Sheet: Thickness required to comply with performance requirements.
      a. Finish: Factory. Parts must be fabricated and welded prior to pre-weathering.
      b. Open Area: 27%
      c. Shape of Openings: Circle
      d. Size of Openings: 1/16” diameter
      e. Spacing of openings: 7/64” centers
      f. Rows of openings: staggered
      g. Thickness: 22 gauge

C. Fabricate with caulk stop angle to retain backer rod and sealant.

2.7 CLOSURES, TRIM, AND BRAKE METALS

A. Form closures and trim from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction, with weathertight joints at exterior installations.

   1. Panel thickness: 0.120 inch (3 mm)


B. Closures and trim may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view and not exposed to weather.
C. Conceal fasteners where possible; otherwise, locate where they are as inconspicuous as possible. Size fasteners to support closures and trim, with fasteners spaced to prevent buckling or waviness in finished surfaces.

D. Drill and tap holes needed for securing closures and trim to other surfaces.

E. Incorporate gaskets where indicated or needed for concealed, continuous seal at abutting surfaces.

F. Miter or cope trim members at corners and reinforce with bent metal splice plates to form tight joints.

2.8 FASTENERS

A. Fastener Materials: Specified by installer.

B. Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.

C. Exposed fasteners should provide corrosion resistance and weathered appearance comparable to the base material.

2.9 GENERAL FINISH REQUIREMENTS

A. Complete mechanical finishes of flat sheet metal surfaces before fabrication where possible. After fabrication, finish all joints, bends, abrasions, and other surface blemishes to match sheet finish.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Parts must be fabricated and welded prior to pre-weathering.

D. Perform pre-weatherization process DMD_149 to initiate, accelerate, and stabilize weathered finish.

E. Before shipping, position material in an exposed area with good drainage to allow for natural weatherization and gravity induced drainage effects to occur.

F. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative formed metal.

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

3.2 INSTALLATION

A. Locate and place decorative formed metal items level and plumb and in alignment with adjacent construction. Perform cutting, drilling, and fitting required to install decorative formed metal.

1. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where needed to protect metal surfaces and to make a weathertight connection.

C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers as indicated.

D. Install concealed gaskets, joint fillers, insulation, sealants, and flashings, as the Work progresses, to make exterior decorative formed metal items weatherproof.

E. Install concealed gaskets, joint fillers, sealants, and insulation, as the Work progresses, to make interior decorative formed metal items soundproof or lightproof as applicable to type of fabrication indicated.

3.3 PROTECTION AND CLEANING

A. Once removed from crates, protect finishes of Weathering Steel from damage during construction period with temporary protective coverings approved by Weathering Steel fabricator.

B. Store Weathering Steel in a ventilated area, away from uncured concrete and masonry, dissimilar metals, and protected from standing water, soiling, and abrasion.

C. Material shall also be kept clean and free of mud, grease, oil, paint, concrete, mortar splatter, and other foreign substances to minimize cleaning needs before installation.

D. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

E. Unless otherwise indicated, clean all metals after installation by washing thoroughly with clean water.
F. Removal of chalk should be achieved by using low pressure water taking care not to disrupt the protective rust.

G. Removal of paint should be achieved using Acetone, low pressure water, and a wiping with a gentle non abrasive pad.

END OF SECTION 057500
PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Woven wire fabrics and grilles, mounting systems and support framing as indicated.

1.3 RELATED SECTIONS

A. Section 055013 – Metal Fabrications: Supporting structure.

1.4 SUBMITTALS

A. Submit under provisions of TPWD’s Uniform General Conditions.

B. Material Certification: Provide material certification (Certs) for each alloy scheduled or required.

C. Shop Drawings: Submit drawings indicating the following:
   1. Mesh pattern name and number.
   2. Panel sizes.
   3. Panel thickness.

D. Verification Samples: For each product specified, provide two (2) samples, minimum size 5 by 7 inches (125 by 175 mm), representing actual product, color, and pattern.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Minimum five (5) years manufacturing similar products.

B. Installer Qualifications: Minimum two (2) years of experience installing similar products.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store products wrapped or otherwise protected and under clean and dry storage conditions until required for installation.
1.7 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer’s absolute limits.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of design
   1. GKD Metal Fabrics: Ellipse 14
      a. Open area: 65%.
      b. Weight per SF: 1.04 lbs.
      c. Overall Thickness: 0.186 inches.
      d. Material: 316 stainless steel.
      e. Finish: Powder coat.
      f. Color: Matching HPC-1 as indicated in drawing finish schedule.

B. Acceptable manufacturer
   4. The Western Group – Flat Top Weave.
   5. Or approved equal by Architect.

C. Perimeter Framing Systems
   1. Flat and angle bars: Sourced from woven wire fabrics manufacturer
      b. Finish: Power coat.
      c. Color: Matching HPC-1 as indicated in drawing finish schedule
      d. Attachment Method:
         1) Follow method recommended by manufacturer.
         2) Mounting holes pacing and positioning as recommended by manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
3.3 INSTALLATION
   A. Install in accordance with manufacturer's instructions.

3.4 PROTECTION
   A. Protect installed products until completion of project.
   B. Touch-up, repair, or replace damaged products before Substantial Completion.

END OF SECTION 057510
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Execution and completion of Rough Carpentry in accordance with the Specifications and Drawings including but not limited to:

1. Dimensional lumber.
2. Cellulose honeycomb wall, floor and roof panels.

1.3 REFERENCES

A. General:

1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.

B. ASTM International.

C. American Wood Preservers Association (AWPA).

D. Douglas Fir Protection Association (DFPA).

E. National Fire Protection Association (NFPA).

1.4 DEFINITIONS

A. Certified Sustainably Harvested Lumber: Dimensional lumber derived from a Well Managed Forest as certified by one of the following Certification Organizations accredited by the Forest Stewardship Council:

1. Green Cross Certification Program: Scientific Certification Systems
2. Smart Wood Certification Program: Rainforest Alliance
3. Pacific Certified Ecological Forest Products: Institute for Sustainable Forestry

B. Salvaged Lumber: Lumber from deconstruction or demolition of existing buildings or structures. Unless otherwise noted, salvaged lumber shall be delivered clean, de-nailed, and free of paint and...
finish materials, and other contamination. Provide documentation certifying products are from salvaged lumber sources.

C. Recovered Lumber: Previously harvested lumber pulled from riverbeds or otherwise abandoned. Unless otherwise noted shall be delivered clean and free of contamination. Provide documentation certifying products are from recovered lumber sources.

1.5 SUBMITTALS

A. Submit under provisions of TPWD's Uniform General Conditions.

B. Certificate: Provide certificate from each manufacturer stating that material is first quality, meets or exceeds the properties of specified materials as specified herein, and is suitable for intended use on this Project. Where recycled lumber materials are used for structural applications or where otherwise noted, include lumber certification and quality grading.

1.6 QUALITY ASSURANCE

A. Inspection: Prior to work of this Section, carefully inspect the installed work of other trades and verify that such work is completed to the point where this installation may properly commence.

B. Discrepancies: In the event of discrepancy, immediately notify the Project Manager. Do not proceed with installation in areas of discrepancy until such discrepancies have been fully resolved.

C. Lumber may be rejected by the Project Manager, whether or not it has been installed, for excessive warp, twist, bow, crook, mildew, fungus, or mold, as well as for improper cutting and fitting.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be properly packed and handled while in transit so as to arrive at the job site in undamaged condition. Manufactured materials shall be delivered in suitable containers plainly marked with brand and manufacturer's name.

B. Storage arrangements shall be subject to Project Manager's approval and shall afford every access for inspection and identification of each item. Lumber shall be piled off the ground, on skids, in a manner which prevents twisting or warping and affords proper ventilation, drainage and protection from termites and decay, rain and excessive sun. Plywood shall be protected from dampness. Material shall be protected from the elements and from damage or deterioration.

C. Damaged or deteriorated materials or assemblies shall not be used in the work and shall be replaced at no extra cost to University.

PART 2 - PRODUCTS

2.1 MATERIALS
A. General: Material shall conform to these specifications and to the applicable current editions of the Standard Specifications of ASTM and CBC. [The source of new lumber shall be certified sustainable harvested lumber.]

B. Lumber Grading:

C. Lumber Grade Marking: Each piece of lumber shall bear the official grade mark of the appropriate inspection bureau of the American Lumber Association, California Redwood Association, WCLIB, etc.

D. Lumber Size and Patterns: Surface four sides, dress sizes to UBC Chapter 23; work to sizes shown. Sizing and surfacing shall be as required and approved for the particular location. Framing shall be sized and where exposed shall be surfaced.


F. Dimensional lumber 2 inches (50 mm) or less in thickness shall have an average moisture content of 19 percent or less but no portion of a shipment shall be over 25 percent. Air dried lumber is desired but, if necessary, lumber may be kiln dried, however, the drying process must be slow and regulated to cause only an amount of checking comparable with air-dried stock. Wood thicker than 2-1/2 inches (63 mm) shall be well seasoned stock, moisture content not to exceed 18 percent.

G. Sills and equipment curbs which rest on concrete shall be foundation grade Redwood or preservative pressure treated Douglas Fir.

H. Framing, blocking, backing, etc., unless otherwise shown, shall be Douglas Fir. All interior wood and plywood used for blocking and built into roofing, or otherwise shown shall receive fire retardant pressure treatment in accordance with paragraph 2.5.B. Exterior stair framing and decking, and wood exposed to the exterior, or otherwise shown, shall receive the preservative type pressure treatment in accordance with paragraph 2.5.A.

I. Dimensional lumber shall be derived from either Certified Sustainable Harvested Lumber or Salvaged and/or Recovered Lumber.

J. Redwood lumber shall be derived from either Certified Sustainable Harvested Lumber or Salvaged and/or Recovered Lumber. No old growth redwood shall be used unless sustainable harvested, salvaged or recovered.

2.2 LUMBER FASTENINGS (EXCEPT FOR PRESERVATIVE PRESSURE TREATED LUMBER FASTENINGS)

A. Nails and Spikes: Common Wire unless otherwise noted
1. Nailing of wood members shall conform to Uniform Building Code and/or as indicated. Box nails are not permitted.
2. Penetration: half-length of nail into piece receiving point.
3. To connect pieces 2 inches (25 mm) net in thickness, 16d nails may be used.
4. Do not drive nails closer together than half their length, nor closer to edge of piece of lumber or timber than 1/4 their length.
5. Spacing and size of nails to be such that splitting will not occur. Pre-bore holes for nails wherever necessary to prevent splitting. Bore diameter of holes smaller than diameter of nail or spike (3/4 dia.).
6. For plywood nailing, barbed plywood nails, size and spacing as indicated. Nails shall have edge distances of not less than 3/8 inch (9.5 mm).
7. Use galvanized nails where exposed to weather or where members are built-in to roofing.

B. Screws: Bright steel wood screws:
1. Screws are to be turned into place, not driven. Self-tapping where required for fastening to metal framing.
2. Countersink where heads will interfere or as required.
3. Screw bolt holes the same diameter and depth as shank; bore holes for threaded portion of screws with bit no larger than base of thread.
4. Use galvanized or cadmium plated screws on fastenings exposed to weather or where members are built-in to roofing.

C. Bolts: Standard mild steel, square or hex head machine bolts with square nuts and malleable iron or steel plate washers, conforming to ASTM A307.
1. To be installed in drilled holes the diameter of the bolt, 1/32 inch (0.8 mm) to 1/16-inch (1.6 mm) over size.
2. Bolting of wood members shall conform to CBC requirements and as called for on the drawings.
3. Washers: Provide bolts bearing on wood, unless noted otherwise on the drawings, with malleable iron, or steel plate washers under heads and nuts. Do no final bolting until structure has been properly aligned.
4. Use galvanized bolts, nuts and washers where exposed to weather or where members are built-in to roofing.

1. Lag screws shall be screwed and not driven into place. Penetration in each timber shall not be less than 2/3 of the length of the lag screw.
2. Hole shall be bored the same diameter and depth as the shank, after which the hole shall be continued to a depth equal to the length of the lag screw with a diameter no larger than 3/4 of the shank diameter.
3. Washers: Provide lag screws bearing on wood with malleable iron or steel plate washers under heads.
4. Use galvanized lag screws and washers where exposed to weather or where members are built-in to roofing.

2.3 ROUGH HARDWARE (EXCEPT FOR PRESERVATIVE PRESSURE TREATED LUMBER FASTENINGS)

A. Provide rough hardware related to carpentry work which is not specifically called out under other headings. This shall include, but not be limited to, the following:
1. General: Fastenings, devices, and other rough hardware not specifically indicated on drawings or specified herein shall be submitted for approval prior to installation. Conform to ASTM A7 or A36.

2. Framing clips, hangers, etc.: Standard products of Universal Company, Simpson, or Silver.

3. Sheet metal straps: Galvanized sheet steel of gauges and designs indicated.

4. Expansion anchors shall have a current ICC evaluation report and be size, number and type shown, installed as described in the evaluation report.

5. Powder Driven Fasteners: shall have a current ICC evaluation report and be size, number and type shown, installed as described in the evaluation report.

2.4 PRESSURE TREATMENT

A. Where called for on the drawings or specified herein, exposed lumber to receive preservative-type pressure treatment shall have a minimum moisture content of 19 percent after pressure treatment and shall be pressure treated using Ammoniacal copper quaternary compound (ACQ). Preservative shall penetrate a minimum of 3/8-inch (9.5 mm) deep into wood. Materials shall be compatible with stain coatings when specified in Division 09 Section 099000 "Paints and Coatings". Fasteners and connectors used with preservative pressure treated lumber shall be G185 hot dip galvanized, Type 304 stainless steel or Type 316 stainless steel.

1. Dimensioned Lumber Posts: AWPA C-2, retention of 0.4 lbs/c.f. per quality standard for LP-22 for in-ground contact.
2. Dimensioned Lumber (all other): AWPA C-2, retention of 0.25 lbs/c.f. per quality standard LP-2 for above ground use.
3. Pre-treated lumber shall be preserved with ACQ Preserve®, Chemical Specialties Inc.
4. Field treatment shall be Boracol® or Impel® Rods, Chemical Specialties Inc. applied in accordance with the manufacturer’s instructions.

B. All interior wood and plywood used for blocking and built into roofing, or otherwise shown, shall receive fire retardant pressure treatment in accordance with American Wood Preservers Association (AWPA). Treat wood with Kopper's “Non-Com”, or Baxter fire retardant treatment, or equal, and provide UL label. Plywood shall have flame spread rating after treatment of 25 or less.

C. Subcontractor shall furnish to the Project Manager, upon delivery of the members to the job, a certificate certifying that the material has been pressure treated as specified.

PART 3 - EXECUTION

3.1 WORKMANSHIP

A. General: Rough carpentry shall produce joints true, tight, and well nailed with members assembled in accordance with the Drawings and with pertinent codes and regulations.

B. Selection of lumber pieces: Carefully select members. Select individual pieces so that knots and obvious defects will not interfere with placing bolts or proper nailing or making proper connections.

3.2 WOOD PRESERVATIVE

A. All exterior framing and wood trims coming in contact with concrete or masonry, whether or not Redwood, and not specified or otherwise shown to be pressure treated shall be treated with ACQ.
Preserve®. Preservatives shall be compatible with stain coatings when specified in Division 09 Section 099000 “Paints and Coatings”.

3.3 SITE-APPLIED WOOD TREATMENT

A. Brush apply two coats of preservative treatment on site cut ends and site cut wood in contact with other wood surfaces.

B. Apply preservative treatment in accordance with manufacturer’s instructions.

C. Allow preservative to cure prior to erecting members.

3.4 INSTALLATION - LUMBER AND DECKING

A. Secure decking perpendicular to framing members with ends staggered over firm bearing where possible.

B. Maintain deck joints of 1/16 inch (1.6 mm).

C. Surface Flatness: +/- 1/4-inch (6 mm) in 10 feet (3 m) maximum.

3.5 FRAMING

A. Install framing in strict accordance with the requirements of CBC Chapter 23 unless more stringent requirements are specified herein or shown on the Drawings.

B. Optimum Value Engineering: Where indicated on drawings or, with prior approval by the Project Manager, the following framing techniques may be employed.
   1. Wall studs spaced at 24 inches (600 mm) on center (Verify with Project Manager and ensure that wall finish materials can meet spans)
   2. On non-bearing walls, or where upper level framing aligns with lower floor, a single continuous top plate may be used.
   3. Built up headers may be used in lieu of solid lumber.
   4. Frame corners with two studs and framing clips.
   5. Use blocking for attachments in lieu of continuous stud.
   7. Layout framing to take advantage of sheathing or siding dimensions.

3.6 CLEANUP

A. At the end of each shift and upon completion of the work, remove debris, rubbish and surplus materials from the site which resulted from work under this section. Do not leave wood, shavings, sawdust, etc. on the ground or buried in fill. Take positive measures to ensure that saw dust and wood shavings do not enter the storm drainage system.
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Wood blocking and nailers.
   2. Wood furring and grounds.
   3. Wood sleepers.
   4. Plywood backing panels.

B. Related Sections include the following:
   1. Division 6 Section 061000 “Rough Carpentry” and Section 061600 “Sheathing”
   2. Division 31 Section 313116 “Termite Control”

1.3 DEFINITIONS

A. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.

B. Lumber grading agencies, and the abbreviations used to reference them, include the following:
   3. NLGA: National Lumber Grades Authority.
   5. WCLIB: West Coast Lumber Inspection Bureau.

1.4 SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained. Architectural drawing would indicate areas where wood-preservative treatment should be applied.

2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.

3. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

4. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

B. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:

1. Preservative-treated wood.
2. Fire-retardant-treated wood.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

B. Deliver interior wood materials that are to be exposed to view only after building is enclosed and weatherproof, wet work other than painting is dry, and HVAC system is operating and maintaining temperature and humidity at occupancy levels.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
3. Provide dressed lumber, S4S, unless otherwise indicated.
2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA C2, except that lumber that is not in contact with the ground or roof and is continuously protected from liquid water may be treated according to AWPA C31 with inorganic boron (SBX).

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat all miscellaneous carpentry, unless otherwise indicated in the drawings:

1. Wood, nailers, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
3. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Furring.

B. For items of dimension lumber size, provide Standard, Stud, or No. 3 grade lumber with 15 percent maximum moisture content of any species.

C. For exposed boards, provide lumber with 15 percent maximum moisture content and any of the following species and grades:

1. Mixed southern pine, No. 2 grade; SPIB.
2. Spruce-pine-fir (south) or spruce-pine-fir, Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.

D. For concealed boards, provide lumber with 15 percent maximum moisture content and any of the following species and grades:
1. Mixed southern pine, No. 2 grade; SPIB.
2. Spruce-pine-fir (south) or spruce-pine-fir, Standard or 3 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
3. Western woods, Standard or No. 3 Common grade; WCLIB or WWPA.

E. For blocking not used for attachment of other construction Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

F. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

G. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.4 PLYWOOD BACKING PANELS

A. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, B-C Plugged, fire-retardant treated, not less than ¾-inch nominal thickness.

2.5 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.

1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails, Brads, and Staples: ASTM F 1667.


D. Wood Screws: ASME B18.6.1.

E. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

F. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).

G. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.

H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
   a. Manufacturer: Basis-of- Design; "HILTI."

2.6 MISCELLANEOUS MATERIALS

A. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.

1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

B. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.

C. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

D. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

E. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.
F. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.

3.2 WOOD GROUND, SLEEPER, BLOCKING, AND NAILER INSTALLATION

A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches (38 mm) wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 WOOD FURRING INSTALLATION

A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.

B. Furring to Receive Plywood: Install 1-by-3-inch nominal- (19-by-63-mm actual-) size furring vertically at 24 inches (610 mm) o.c.

3.4 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061050
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Wall sheathing.
   2. Parapet sheathing.

B. Related Requirements:
   1. Division 6 Section 061000 “Rough Carpentry”, Section 061050 “Miscellaneous Carpentry” for plywood backing panels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

   1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
   2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
   3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5516.
   4. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.4 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:

   1. Wood-preservative-treated plywood.
   2. Fire-retardant-treated plywood.
1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: As tested according to ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL’s "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 PRESERVATIVE-TREATED PLYWOOD

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for exterior construction not in contact with ground, and use Category UC4a for items in contact with ground.

B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

2.3 FIRE-RETARDANT-TREATED PLYWOOD

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Use treatment that does not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.

C. Application: Treat plywood indicated on Drawings, and the following:

1. Roof and wall sheathing within 48 inches (1220 mm) of walls.
2. Roof sheathing.
2.4 WALL SHEATHING

A. Glass-Mat Gypsum Sheathing: ASTM C 1177/1177M.
   1. Type and Thickness: Type X, 5/8 inch thick.
   2. Size: Minimum 48 by 96 inches for vertical installation.
   3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. CertainTeed Corporation.
      b. Continental Building Products, LLC.
      c. Georgia-Pacific Building Products.
      e. Temple-Inland Building Products by Georgia-Pacific.
      f. USG Corporation.

2.5 PARAPET SHEATHING

A. Plywood Sheathing: DOC PS 2, Exterior, Exposure 1, Structural sheathing.
   1. Nominal Thickness: Not less than 1/2 inch (13 mm)

2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   1. For parapet and wall sheathing, provide fasteners of Type 304 stainless steel

B. Nails, Brads, and Staples: ASTM F 1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Screws for Fastening Sheathing to Wood Framing: ASTM C 1002.

E. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

F. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.
   1. For steel framing less than 0.0329-inch (0.835-mm) thick, use screws that comply with ASTM C 1002.
   2. For steel framing from 0.033- to 0.112-inch (0.84- to 2.84-mm) thick, use screws that comply with ASTM C 954.
SHEATHING

2.7 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

A. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C 834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:
   1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
   2. ICC-ES evaluation report for fastener.

D. Coordinate wall and parapet sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

F. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 GYPSUM SHEATHING INSTALLATION

A. Comply with GA-253 and with manufacturer's written instructions.
   1. Fasten gypsum sheathing to cold-formed metal framing with screws.
   2. Install panels with a 3/8-inch (9.5-mm) gap where non-load-bearing construction abuts structural elements.
   3. Install panels with a 1/4-inch (6.4-mm) gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.

C. Vertical Installation: Install vertical edges centered over studs. Abut ends and edges with those of adjacent panels. Attach at perimeter and within field of panel to each stud.

1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of panels.
2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

D. Seal sheathing joints according to sheathing manufacturer's written instructions.
1. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

END OF SECTION 061600
PART 1 GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Western SPF(Spruce-Pine-Fir) wood products including the following and as indicated on the Drawings:

   1. Interior Ceilings and Wall Paneling.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of process and factory-fabricated product. Indicate component materials, dimensions, profiles, textures, and colors and include construction and application details.

      1. Preparation instructions and recommendations.
      2. Storage and handling requirements and recommendations.
      3. Installation methods.
      4. Include data for fire-retardant coating from manufacturer.

   B. Research/Evaluation Reports: For fire-retardant-coated wood.

   C. Verification Samples: For each finish product specified, two samples, representing actual product and color.

1.4 QUALITY ASSURANCE
   A. Installer Qualifications: Installer shall be licensed, registered or otherwise acceptable to authorities having jurisdiction to install exterior building products.

1.5 DELIVERY, STORAGE, AND HANDLING
   A. Inspect the materials upon delivery to assure specified products have been received. Store products in a safe area, away from construction traffic. Store under cover and off the ground, protected from moisture.

1.6 PROJECT CONDITIONS
   A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.
1.7 WARRANTY

A. Material Warranty: Provide manufacturer's standard warranty and as follows:
   1. 15 year warranty against rot, delamination and excessive swelling.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by, but not limited to, one of the following:

   1. Woodtone, “Fineline” series panels in “Smoky Bourbon”
   2. Great American Spaces, “Easy Barnwood” collection panels in “Covered Bridge”

2.2 TRIM (WD-1 AND B-2)

A. Product: Wall and Ceiling Paneling.
   1. Species: Lodgepole Pine / Englemann Spruce ELSP.
   2. Texture: Square-edge face.
   3. Profile dimensions as scheduled on the drawings from manufacturer’s standard width and thickness.
      a. Square-edge.
   4. Finish: Factory pre-finished as indicated

2.3 FINISH COATING SYSTEM


B. System: Coated on all 6 sides.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Finish materials on all ends and sides and ends. Apply touch up coating on new cuts. Factory finishing is preferred.
3.3 PROTECTION

A. Protect installed products until completion of project.
B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 062210
SECTION 072100

THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Extruded polystyrene foam-plastic board.
2. Polyisocyanurate foam-plastic board.

B. Related Requirements:

1. Section 061600 "Sheathing" for foam-plastic board sheathing installed directly over steel framing.
2. Section 075423 "Thermoplastic Polyolefin (TPO) Roofing" for insulation specified as part of roofing construction.
3. Section 092600 "Gypsum Board assemblies" for sound attenuation blanket used as acoustic insulation.
4. Section 074113.16 “Standing-Seam Metal Roof Panels” for insulation specified as part of roofing construction.
5. Section 074100 “Insulated Metal Roof Panels” for insulation specified as part of roofing construction

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.

3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD

A. Extruded Polystyrene Board, Type X: ASTM C578, Type X, 15-psi minimum compressive strength; unfaced; maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E84.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. DiversiFoam Products.
   b. Dow Chemical Company (The).
   c. MBCI.
   d. Owens Corning.


3. R-Value Minimum Requirement: Wall (Framing Cavity): R-5 Continuous Insulation

2.2 GLASS-FIBER BLANKET

A. Glass-Fiber Blanket, Unfaced: ASTM C665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E84; passing ASTM E136 for combustion characteristics.

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

2. R-Value Minimum Requirement: Wall (Framing Cavity): R-13

2.3 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AGM Industries, Inc.
b. Gemco.

2. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.

B. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Gemco. 90-Degree Insulation Hangers

2. Angle: Formed from 0.030-inch-thick, perforated, galvanized carbon-steel sheet with each leg 2 inches square.
3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.

C. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AGM Industries, Inc.; RC150.
   b. AGM Industries, Inc.; SC150.
   c. Gemco; Dome-Cap.
   d. Gemco; R-150.
   e. Gemco; S-150.

2. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:
   a. Crawl spaces.
   b. Ceiling plenums.
   c. Attic spaces.
   d. Where is required

D. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space of 2 inches between face of insulation and substrate to which anchor is attached.

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

E. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AGM Industries, Inc.; TACTOO Adhesive.
   b. Eckel Industries of Canada; Stic-Klip Type S Adhesive.
   c. Gemco; Tuff Bond Hanger Adhesive.

2.4 ACCESSORIES
   A. Insulation for Miscellaneous Voids:
      1. Glass-Fiber Insulation: ASTM C764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E84.
   B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.
   C. Asphalt Coating for Cellular-Glass Block Insulation: Cutback asphalt or asphalt emulsion of type recommended by manufacturer of cellular-glass block insulation.
   D. Eave Ventilation Troughs: Preformed, rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide ventilation between insulated attic spaces and vented eaves.

PART 3 - EXECUTION
3.1 PREPARATION
   A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL
   A. Comply with insulation manufacturer's written instructions applicable to products and applications.
   B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
   C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
   D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.
3.3 INSTALLATION OF CAVITY-WALL INSULATION

A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face and as recommended by manufacturer. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates.

1. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose.

3.4 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.

B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:

1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft..
2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.5 INSTALLATION OF ROOF INSULATION

A. Install foam-plastic board insulation in roof construction according to manufacturer's written instructions.

1. Mechanically fasten boards to substrate at NRCA recommended spacing.
2. Apply insulation boards parallel to roof perimeter long edges. Stagger end joints.
3. Lay insulation with edges in moderate contact without forcing.
4. Cut installation to fit neatly to perimeter blocking and around penetrations.

3.6 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100
FLUID-APPLIED VAPOR-PERMEABLE MEMBRANE AIR BARRIERS (VPAB)

PART 1 - GENERAL

1.1 SUMMARY:

A. Work of this section includes liquid-applied, vapor-permeable air barrier membrane system and flexible dashing for application to exterior sheathing, masonry, concrete and other substrates as indicated on the drawings and in the terra cotta clay tile rainscreen system.

B. Related work specified elsewhere:

1. Concrete.
2. Masonry.
3. Sheathing.
4. Insulation.
5. Roofing system.
6. Wall panels.
7. Waterproofing.
8. Joint sealants.
9. Door frames.

1.2 PERFORMANCE REQUIREMENTS:

A. Air leakage: Materials used as air barriers shall have air leakage of less than 0.004 cfm per square foot (0.02 L/s/sq m) when tested in accord with ASTM E2357-11 or ASTM E2178-11 and ASTM E283-04(2012).

B. Water vapor permeance: Minimum 11 perms when tested in accord with ASTM E96-14.

C. Combustibility: Air barrier assembly shall have been tested and passed NFPA 285 with regard to vertical and lateral fire propagation.

1.3 ACTION SUBMITTALS:

A. General: In compliance with TPWD’s Uniform General Conditions and as specified herein,

B. Product data: Submit manufacturer’s product data including membrane and accessory material types, composition, descriptions and properties, installation instructions and substrate preparation recommendations.

C. Shop drawings: Indicate locations and extent of air barrier system, including details of typical conditions, intersections with other building envelope systems and materials; membrane counterdashes and details showing bridging of envelope at substrate changes, details of sealing penetrations, and detailed flashing around windows and doors.

D. Samples: Provide one 1'-0" by 1'-4" or 1'-0" length of manufacturer’s representative samples of the following:

1. Air barrier.
2. Flexible flashing membrane.
1.4 INFORMATIONAL SUBMITTALS:

A. Test Reports: Submit test reports indicating compliance with specified performance characteristics and requirements.

B. Evaluation reports. For water-resistive barrier and flexible dashing, from ICC-ES.

C. Sample warranty: Submit a sample warranty identifying the terms and conditions of the

1.5 PERFORMANCE REQUIREMENTS:

A. Provide an air barrier constructed to perform as a continuous air barrier, and as liquid water drainage plane lashed to discharge any incidental condensation or water penetration.

B. The building envelope shall be designed and constructed with a continuous air barrier to control air leakage into, and out of the conditioned space.

C. The air barrier shall be continuous, with joints made airtight. System shall meet the performance characteristics specified herein.

1. System shall be capable of withstanding positive and negative combined wind, fan, and stack pressures on the envelope without damage or displacement, and shall transfer the load to the structure,
2. System shall not displace adjacent materials under full load.
3. The air barrier shall be joined in an airtight and flexible manner, allowing for the relative movement of systems due to thermal and moisture variations and creep.

D. Penetrations of the air barrier and paths of air infiltration/exfiltration shall be made airtight.

E. The air barrier assembly shall meet NFPA 285 requirements.

1.6 QUALITY ASSURANCE:

A. Applicable standards:

1. ASTM International (ASTM), as referenced herein.

B. Manufacturer’s qualifications: Air barrier systems shall be manufactured and marketed by a firm with a minimum of 15 years’ experience in the production and sales of waterproofing. Manufacturers proposed for use, but not named in these specifications shall submit evidence of ability to meet specified requirements, and include a list of projects of similar design and complexity completed within the past five years.

C. Installer’s qualifications: Installer shall demonstrate qualifications to perform the work of this Section by submitting the following:

1. List of at least three (3) projects contracted within the past five (5) years of similar scope and complexity to this project carried out by the firm and site supervisor.
2. Installer shall show evidence of adequate equipment and trained personnel to successfully complete the project in a timely manner.
D. Inspection and testing: Cooperate and coordinate with Owner's inspection and testing agency. Do not cover any installed air barrier membrane until it has been inspected, tested and approved.

E. Allow access to work site by the air barrier manufacturer's representative.

F. Provide products which comply with state and local regulations controlling use of volatile organic compounds (VOC's).

G. Materials: Fluid-applied air barrier shall be water-based, low-VOC, elastomeric, single-component, polymer-modified, asphaltic membrane,

1.7 DELIVERY, STORAGE, AND HANDLING.

A. Deliver materials and products in labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from damage from sunlight, weather, excessive temperatures and construction operations. Remove damaged material from site and dispose of in accordance with applicable regulations.

B. Do not double-stack pallets of membrane components on job site. Provide cover on top and all sides, allowing for adequate ventilation.

C. Protect air barrier components from freezing and extreme heat. Store materials at temperatures of 40 degrees F and rising.

D. Protect air barrier components from exposure to sunlight. Corr components with UV-resistant covering until installed.

E. Sequence deliveries to avoid delays, and to minimize on-site storage.

1.8 PROJECT CONDITIONS:

A. Perform work only when existing and forecasted weather conditions are within the limits established by the manufacturer of the materials used.

1. Do not apply at temperature below 40 degrees F.
2. Comply with manufacturer's exposure limitation requirements for protection from sunlight and weathering.
3. Proceed with installation only when the substrate construction and preparation work is complete and in condition to receive the air barrier membrane.

1.9 WARRANTY:

A. Contractor's warranty: Contractor shall warrant that the work of this section in in compliance with project requirements and free from faults and defects in materials and workmanship for period of one years from Date of Substantial Completion.

B. Manufacturer’s warranty: Submit a written warranty, signed by membrane manufacturer, agreeing to replace membrane components and materials that do not comply with requirements.

1. Warranty does not include failure of membrane due to failure of substrate prepared and treated according to requirements.
2. Warranty period: Fix years from Date of Substantial Completion.
PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Source limitations: Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.

2.2 MANUFACTURERS:

A. Acceptable products include:

2. Carlisle Coatings and Waterproofing, Fire Resist Barritech VP.

B. Contractor to verify that selected system has been tested/approved to work with other facade components per NFPA 285 requirements.

2.3 MATERIAL:

A. Membrane description: Seamless, vapor-permeable, monolithic, elastomeric membrane designed for application to exterior above-grade walls to seal assemblies and prevent air infiltration/exfiltration, while allowing the passage of moisture vapors.

B. Air barrier thickness: Wet film thickness and dry film thickness shall be as recommended by air barrier manufacturer's product data.

C. Application temperature: Comply with manufacture’s requirements, minimum 40 degrees F.

2.4 ACCESSORY MATERIALS:

A. Joint and transition membrane flashing tape:

1. Acceptable products:

a. Tremco, Inc., ExoAIR 110 and ExoAIR 110LT (low-temperature),
b. Carlisle Coatings and Waterproofing, CCW-705 Air & Vapor Barrier Strips.
c. Henry Company, Blueskin VPAB.

2. Description: 40 mil thickness self-adhesive rubberized asphalt with a bonded cross-laminated, high-density polyethylene film. Membrane shall be interleaved with disposable silicone-coated release paper until installed.

B. Flexible membrane flashing:

1. Acceptable products:

a. Tremco, ExoAir TWF.
b. Carlisle Coatings and Waterproofing, CCW-705-TWF,
c. Henry Company, Blueskin TWF.

2. Description: 40 mil thickness self-adhesive rubberized asphalt with a bonded cross-laminated, high-density polyethylene film. Membrane shall be interleaved with disposable silicone-coated release paper until installed.
C. Primer.

1. Acceptable products:
   b. Carlisle Coatings and Waterproofing, AWP.

2. Description: Water-based, low-VOC, latex liquid for extruded polystyrene, concrete, masonry, gypsum sheathing, wood, metal, and painted substrates.
   a. Flash point: No flash to boiling point,
   b. Solvent type: Water,
   c. Application temperature: 40 degrees F and above.
   d. Freeze/thaw stability: 5 cycles min.

D. Penetration and termination mastic:

1. Acceptable product:
   a. Tremco, ExoAir Termination Mastic.
   b. Carlisle Coatings and Waterproofing, CCW LM 800 XL.
   c. Henry Company, HE925 BES Sealant.

2. Description: Low-VOC rubberized asphalt-based mastic or urethane sealant,
   a. Elongation: 450-550%,
   b. Seals joints up to 1" wide.

E. Through-wall flashing: Refer to Section 076200 – Sheet Metal Flashing and Trim.

PART 3 - EXECUTION

3.1 EXAMINATION AND SUBSTRATE PREPARATION:

A. Examine conditions, with installer present, for compliance with requirements for Installation, tolerances and other specific conditions affecting performance of air barrier.

B. Refer to manufacturer's product data for requirements for preparation of substrates.

1. Surfaces shall be dry, sound and free of voids, spalled areas, loose aggregate and sharp protrusions.
2. Remove contaminants such as grease, oil and wax from exposed surfaces,
3. Remove dust, dirt, loose stone and debris.
4. Use repair materials and methods that are acceptable to manufacturer.

C. Exterior sheathing panels: Ensure that boards are sufficiently stabilized with corners and edges fastened with appropriate screws.

1. Tape sheathing end and edge joints with specified self-adhesive joint and transition tape.
2. Remove silicone-coated release paper from tape and position tape carefully Before placing it against surface.
3. when properly positioned, place against surface by pressing firmly into place by hand roller.
4. Overlap adjacent pieces 2" and roll seams with a hand roller.
5. Seal top edges of tape with termination mastic.

D. Masonry substrates: Block shall have smooth trowel-cut mortar joints, Fill voids and holes, particularly in mortar joints, with a lean mortar mix, non-shrinking grout or parge coat.
E. Related materials: Treat construction joints and install flashing as recommended by
Manufacturer’s product data.

3.2 AIR BARRIER INSTALLATION:

A. General: Comply with approved shop drawings and manufacturer’s product data and
installation recommendations for air barrier and accessory materials.

B. Comply with air barrier manufacturer’s instructions regarding sequence of application of
air barrier, transition membrane and flashings: Comply with selected manufacture’s
product data and installation instructions.

C. Application of fluid-applied air barrier membrane:

1. Apply a continuous uniform film at wet film thickness as recommended by air
barrier manufacturer’s product data, using multiple, overlapping passes.
2. Use application methods and equipment as recommended by air barrier
manufacturer.
3. When spraying, use a cross-hatching technique (alternating horizontal and
‘vertical passes) to ensure even thickness and courage.
4. Return Quid-applied membrane into openings minimum of 2”.
5. Seal masonry ties and other penetrations as work progresses.
6. Inspect air membrane before covering and repair any punctures or damaged
areas with air membrane or other pre-approved mastic, extending repair
material a minimum of 6” beyond the puncture of damage.

D. Application of transition membrane:

1. Apply transition membrane with a minimum overlap of 3” onto each surface
at beams, columns and joints as indicated in detail drawings,
2. Tie into window and door frames, spandrel panels, roof and floor intersections
and changes in substrate.
3. Use pre-cut, easily handled lengths for each location.
4. Remove silicone-coated release paper and position membrane flashing
carefully before placing it against surface.
5. when properly positioned, place against surface by pressing firmly into place by
hand roller.
6. Overlap adjacent pieces 2” and roll seams with a hand roller.
7. Seal top edge of flashing with termination mastic.
8. Inspect transition membrane before covering and repair any punctures
or damaged areas with transition membrane or other pre-approved
mastic, extending repair material a minimum of 6” beyond the puncture of damage.

3.3 INSTALLATION OF FLEXIBLE FLASHING:

A. Metal pan flashing receptor: Install continuous metal pan flashing backup as shown on
the drawings.

1. Start metal pan dashing held back 1/2” from outside face of masonry. Extend
through cavity, rising not less than 2”.
2. Form joints in metal flashing by using 4” minimum flat laps between adjacent
flashing pieces, with full continuous bed of silicone sealant in lap. Tool/scrape
away excess sealant.
3. Bed metal flashing to steel shelf angles in full, troweled-on bed of silicone sealant.
Tool/scrape away excess sealant.

B. Install flexible flashing in accord with manufacturer’s product data and as specified herein.

1. Precut pieces of flashing to easily handled lengths for each location,
2. Remove silicone-coated release paper and position flashing carefully
before placing it against surface.

3. When positioned, place against surface by pressing into place by hand roller.
   Adhere flashing to substrate to prevent water from migrating under flashing,
4. Overlap adjacent pieces 2” and roll seams with a hand roller.
5. Flexible flashing shall not be permanently exposed to sunlight.
6. At heads, sills and flashing terminations, extend flashing minimum 8” beyond
   openings, each side, and turn up ends a minimum of 2” and make folds to form
   end dams, with seams sealed to ensure drainage through weeps and not
   into cavity. 
7. Seal top edge of flashing with termination mastic in accord with manufacturer’s
   product data. Apply a bead of mastic/sealant along top edge, seams and cuts of
   flashing in accord with product data.
8. Do not allow rubberized asphalt surface of dashing membrane to come in contact
   with poly-sulfide sealants, creosote, uncured coal tar products or EPDM.

C. Install flexible flashing at exterior door jambs and heads, window jambs, heads and sills,
   other wall openings, lintels, shelf angles; continuous, in same bed joint as weep hole.

D. Prime substrates to receive membrane flashing using specified primers, and
   complying with membrane manufacturer's instructions.

  1. Primed substrates shall allow full bond of adhesive side of membrane to
     substrates.
  2. Mechanically attach specified continuous termination bar at top edge of flashing,
     against backup substrate, listened at 16” o,c. maximum, as herein specified.

E. At masonry and concrete backup:

  1. At masonry walls, start flexible flashing 1” in from outside face of exterior wythe,
     extend through cavity, rising not less than 12”, and terminate minimum 1”
     above mortar joint of interior wythe, in accord with membrane manufacturer's
     details. Seal top edge with continuous bead of mastic.
  2. At concrete walls, start flexible membrane dashing 1” in from outside face of
     exterior wythe, extend through cavity, rising not less than 12”. Terminate against
     substrate, in accord with membrane manufacturer's details. Seal top edge with
     continuous bead of mastic.
  3. Overlap flashing 2” and roll all overlaps with a steel hand roller. Apply a bead
     of mastic/sealant at seams and cuts of flashing in accord with product data.
     Seal top edges with continuous bead of sealant.
  4. Secure top/termination edge of flexible flashing with termination bar as further
     specified herein.
  5. Top flashing at exterior wythe with full bed of fresh mortar as masonry is
     continued.

F. At stud walls: Start self-adhering flashing 1” in from outside face of exterior wythe,
   extend through cavity, rising not less than 12”, and terminate against sheathing.

  1. Set in continuous 1-1/2” wide bed of adhesive, and mechanically fastened to each
     framing stud.
  2. Coordinate dashing installation with application of air banner to ensure barrier
     overlaps upper edge of flashing in shingle fashion,
  3. Overlap flashing 2” and roll all overlaps with a steel hand roller. Apply a bead
     of mastic/sealant at seams and cuts of flashing in accord with product data.
     Seal top edges with continuous bead of sealant.
  4. Secure top/termination edge of flexible dashing with termination bar as further
     specified herein.
  5. Top flashing at exterior wythe with full bed of fresh mortar as masonry is
     continued.
G. Termination bar: Install continuous termination bar at flashing top termination edges, at flashing terminations at expansion and control joints, and where shown on the drawings. Mechanically fasten to each stud, and mechanically fasten at 16” o.c. at CMU walls and concrete walls.

1. Anchor termination bar using stainless steel anchors and fasteners.
2. Apply specified silicone sealant at top edge of termination bars.

H. Extend dashing minimum 8” beyond openings, each side. Turn ends up to heights shown on the drawings, to form end dams and to ensure drainage through weeps and not into cavity.

I. Install in maximum lengths to avoid joints. Fold corners without cutting. Apply a detail coat of liquid mastic over the folds. Adhere flashing to shelf angles. Provide adhesive cant to force water to exterior.

3.4 PROTECTION AND CLEANING:

A. Remove masking materials after installation. Clean stains on materials that would be exposed in completed work using procedures as recommended by manufacturer.

B. Air barrier is not suitable for prolonged exposure to sunlight or weathering. Protect from effects of sunlight and weathering in accord with manufacturer’s exposure limitations.

C. Schedule work to ensure that air barrier system is covered as soon as possible after installation.

D. Cap and protect exposed back-up walls against wet weather conditions during and after application of membrane, Drying time varies depending on temperature and relative humidity. Protect air barrier work against wet weather conditions for a minimum of 24 hours.

E. Protect air barrier system from damage during subsequent operations.

END OF SECTION 072726
TPWD Cedar Hill State Park Flood Repairs  
TPWD No. 128269  
HZ No. R302179.02

INSULATED METAL ROOF PANELS

SECTION 074100  
INSULATED METAL ROOF PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including TPWD’S Uniform General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 RELATED SECTIONS
A. 061000 "Rough Carpentry" for wood nailers, curbs, and blocking
B. Section 074293 "Soffit Panels" for metal panels used in horizontal soffit applications.
C. Section 076200 "Sheet Metal Flashing and Trim" for custom- and site-fabricated sheet metal flashing and trim
D. Section 077100 “Roof Specialties” for roof-edge drainage system

1.3 SUMMARY
A. Section Include:
   1. Steel faced factory insulated roof panels
   2. Accessories including fasteners, perimeter trim and penetration treatments

1.4 PERFORMANCE REQUIREMENTS
A. ASTM International
   1. ASTM A792; Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
   2. ASTM B117; Standard Practice for Operating Salt Spray (Fog) Apparatus
   4. ASTM D523; Standard Test Method for Specular Gloss
   5. ASTM D522; Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
   6. ASTM D714; Standard Test Method for Evaluating Degree of Blistering of Paints
   9. ASTM D2244; Standard practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
10. ASTM D2247; Standard Practice for Testing Water Resistance of Coatings in 100 percent Relative Humidity
12. ASTM D3359; Standard Test Methods for Measuring Adhesion by Tape Test
13. ASTM D3363; Standard Test Method for Film Hardness by Pencil Test
14. ASTM D4145; Standard Test Method for Coating Flexibility of Prepainted Sheet
15. ASTM D4214; Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films
16. ASTM E72; Standard Test Methods of Conducting Strength Tests of Panels for Building Construction
17. ASTM E84; Standard Test Method for Surface Burning Characteristics of Building Materials
18. ASTM A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

B. Underwriters Laboratories
   1. UL 580; Tests for Uplift Resistance of Roof Assemblies

C. Factory Mutual
   1. FM 4471; Approval Standard for Class 1 Panel Roofs

1.5 ACTION SUBMITTALS

A. Product Data: Submit manufacturer current technical literature for each type of product.

B. Shop Drawings: Submit detailed drawings and panel analysis showing:
   1. Profile
   2. Gauge of both exterior and interior sheet
   3. Location, layout and dimensions of panels on roof structure
   4. Location and type of fasteners
   5. Shape and method of attachment of all trim
   6. Locations and type of sealants

C. Panel Analysis: Provide panel calculations to indicate compliance with max deflection of L/240 for the indicated design loads. Include effects of thermal differential between the exterior and interior panel facings.

D. Samples: Each color indicated. 6 inches by 6 inches minimum.

E. Miscellaneous Certifications:
   1. Submit documentation that products have been certified in accordance with ISO 14025.
F. Quality Assurance Submittals

1. Design Data, Test Reports: Provide manufacturer test reports indicating product compliance with requirements.
2. Manufacturer Erection Instructions: Provide manufacturer’s written installation instructions including proper material storage, material handling, installation sequence, panel location(s), and attachment methods, details and required trim and accessories.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Manufacturer shall have a minimum of five (5) years experience in the production of insulated metal standing seam roof panels. Manufacturer shall demonstrate past experience with examples of projects of similar type and exposure.
2. Manufacturer to be registered with a Program Operator with a Certified, Environmental Product Declaration, in conformance with ISO 14025, for Insulated Metal Panels.

B. Installer Qualifications:

1. Installer shall be authorized by the panel manufacturer and the work shall be supervised by a person having a minimum of five (5) years experience installing insulated metal standing seam roof panels on similar type and size projects.
2. Installation shall be in accordance with manufacturer’s installation guidelines and recommendations.

C. Wind and Uplift Rating

1. Design Uplift Load: 20 psf
2. Units shall be rated and carry the following listings:
   a. Factory Mutual 1-105 uplift rating for 5 foot spans with minimum 14 gauge purlins
   b. Factory Mutual 4771 – Class 1 Approval
   c. UL 580, Class 90 uplift ratings for 5 foot spans with a minimum 14 gauge purlins
   d. UL 580, Class 90 uplift rating for panels attached to 20 gauge decking with fastening, 3 foot on center.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver panel materials and components in manufacturer’s original, unopened, undamaged packaging with identification labels intact.

B. Store roofing panel materials on dry, level, firm, and clean surface using the three inch factory provide foam supports under the panels. Use of wood substitute is not acceptable. Stack no more than two bundles high. Elevate and ventilate to allow air to circulate and moisture to escape.
1.8 WARRANTY

A. Limited Warranty: Standard form in which manufacturer agrees to repair or replace items that fail in materials or workmanship within specified warranty period. The items covered by the warranty include structural performance and finish performance.

1. Warranty Period: Two (2) years from date of Substantial Completion, or 2 years and 6 months from the date of shipment from manufacturer's plant, whichever occurs first.

B. Finish Warranty: Standard form in which manufacturer agrees to repair or replace metal panels that evidence deterioration of fluoropolymer finish, including flaking or peeling from approved primed metal substrate, chalk in excess, and/or color fading.

1. Warranty Period: Twenty (20) years from date of Substantial Completion, or 20 years and 3 months from the date of shipment from manufacturer's plant, whichever occurs first.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements; provide products by, but not limited to, one of the following:

1. Basis of Design: Kingspan KingZip
2. MetlSpan CFR

2.2 STANDING SEAM ROOF PANELS

A. Panel Description:

1. Panel thickness: 2 1/2 inches thick.
2. Panel width: 42 inch wide
3. Panel length: As indicated on drawings.
4. The side joint shall consist of a 2 inch vertical sidelap, mechanically seamed, with fasteners and thermally broken attachment clip completely concealed within the side joint.
5. Exterior Face of Panel:

   a. Material: AZ50/Galvalume/Zincalume per ASTM A 792
   b. Profile: Shallow “minor rib”
   c. Texture: Non-embossed
   d. Gauge: 24 gauge
   e. Yield: 33 ksi minimum
   f. Exterior Finish: Valspar Fluropon PVDF finish, dry film thickness of 1.0 mil including primer.

      1) Color: Color indicated.
      2) SRI: Minimum of 29.

6. Interior Face of Panel:

   a. Material: AZ50/Galvalume/Zincalume per ASTM A792
b. Profile: Shallow “minor rib”
c. Texture: Non-embossed
d. Gauge: 26 gauge
e. Yield: 33 ksi minimum
f. Interior Finish: Valspar Dynapon modified polyester finish with a total minimum dry film thickness of 1.0 mil including primer.

1) Color: Same as exterior face of panel.

7. Insulating Core: Minimum 95 percent closed cell structure urethane modified isocyanurate core with the following minimum physical properties:

   a. Density Nominal: 2.4 pcf
   b. Shear Strength: 25 psi (to rise)
   c. Tensile Strength: 23 psi
   d. Compressive Strength: 14-22 psi
   e. Surface burning characteristics when tested in accordance with ASTM E84:

      1) Flame Spread: less than 25
      2) Smoke Developed: less than 450

8. R-Value minimum requirement: R-25 Continuous Insulation

B. Physical Characteristics:

1. Structural Test: Design shall be verified by representative structural test for wind loads in accordance with ASTM E72. The deflection criteria shall be L/240.
2. Thermal Properties: The panel shall provide a nominal R-value of 7.2 [hr·ft²·°F/Btu] per inch thickness when tested in accordance with ASTM C 518 at 75°F mean temperature and 8.0 [hr·ft²·°F/Btu] per inch thickness when tested in accordance with ASTM C 518 at 35°F mean temperature
3. Fatigue Test: There shall be no evidence of metal/insulation interface delamination when the panel is tested by simulated wind loads of 20 psf (positive and negative loads), when applied for two million alternate cycles.
4. Bond Strength: No metal primer interface corrosion and/or delamination shall occur after 1000 hours at 140 deg. F and 100 percent relative humidity. No delamination shall occur after 2-1/2 hours in a 2 psi 212 deg. F autoclave.
5. Water Penetration: There shall be no uncontrolled water leakage at pressures of up to 20 psf when tested in accordance with ASTM E331 and ASTM E1646. Tested assembly must include endlap and sidelap conditions.
6. Air Infiltration: Air infiltration through the roof shall not exceed 0.003 cfm/sf at 6.24 psf air pressure differential when tested in accordance with ASTM E283 and ASTM E1680. Tested assembly must include endlap and sidelap conditions.

C. Finish Characteristics:

1. Gloss: 15 ± 5 tested in accordance with ASTM D523
2. Pencil Hardness: HB – H tested in accordance with ASTM D3363
3. Flexibility, T-Bend: 1-2T bend tested in accordance with ASTM D4145
4. Flexibility, Mandrel: No cracking tested in accordance with ASTM D522
5. Adhesion: No adhesion loss tested in accordance with ASTM D3359
6. Reverse Impact: No cracking or adhesion loss tested in accordance with ASTM D2794
7. Abrasion Resistance: 65 ± 10 liters tested in accordance with ASTM D968
INSULATED METAL ROOF PANELS

8. Graffiti Resistance: Minimal effect
9. Acid Pollutant Resistance: No effect tested in accordance with ASTM D1308
10. Salt Fog Resistance: Passes 1000 hours tested in accordance with ASTM B117
11. Cyclic Salt Fog and UV Exposure: Passes 2016 hours tested in accordance with ASTM B5894
12. Humidity Resistance: Passes 1500 hours when tested in accordance with ASTM D2247 and D714
13. Color Retention: Passes 5000 hours when tested in accordance with ASTM G153 and G154
14. Chalk Resistance: Maximum chalk is a rating of 8 when tested in accordance with ASTM D4214, Method A
15. Color Tolerances: Greater than 5∆E units on panels when tested in accordance with ASTM D224.

2.3 ACCESSORIES

A. Fasteners:
1. Self drilling fasteners shall be corrosion resistant plated steel, designed to resist maximum negative pulloff loads and hold the face sheet mechanically to the structural support.
2. Panel attachment clip shall be two pieces and fully concealed within the panel sidejoint. Base clip shall be a minimum 14 gauge galvanized, and top clip shall be a minimum 20 gauge stainless steel with an integral thermal break.
3. Vibration resistant type (anti-backout threads) fasteners. Self-drilling flathead screws with sealing washers and square drives, designed to resist back out by increasing thread friction as screw loosens.

B. Perimeter Trim and Penetration Treatments: All required trim and metal flashing with same coating, color, and gauge as the exterior face of the insulated metal roof panel.

C. Butyl Tape: Per panel manufacturer's recommendations for panel to panel and panel to trim seal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine alignment of the structure and supports prior to installing the insulated metal roof panels.
1. Structure Tolerance: In the plane of the roof 0 inches inward, plus 1/2 inch outward
2. All deviations from structural tolerances shall be corrected by the responsible party prior to installation of the panels.

B. Examine individual panels upon removing from the bundle; both edges should be visually examined and any slight overfill of insulation should be carefully removed.
3.2 PANEL INSTALLATION

A. Remove protective film before installation, or immediately thereafter to prevent sunlight damage.

B. Cut panels, where indicated on shop drawings, using a power circular saw with fine tooth carbide tip blades or a band saw prior to installation. Ventilate area where polyurethane dust is generated. Personnel should wear respiratory and eye protection devices.

C. Apply butyl sealant vapor seal around interior perimeter of roof assembly per panel manufacturer’s instructions.

D. Apply butyl tape on panel sidelaps and clip assemblies per panel manufacturer’s instructions.

E. Secure units to the steel supports with manufacturer’s recommended fastener.

F. Place panel fasteners through predrilled top clip and base clip, concealed within the side joint of the panel.

1. Heads of concealed fasteners shall be insulated from the exterior environment to prevent condensation and “ice balling” from occurring on the fastener shaft.

G. Apply endlap sealing tape and butyl to panel surface to be lapped per manufacturer’s instructions.

H. Endlap panel stitch fasteners to be vibration resistant type.

I. As each panel is installed, crimp hidden clip assembly prior to placement of next panel.

J. Repair or replace metal panels and trim that have been damaged.

3.3 TRIM INSTALLATION

A. Place trim to determine the location of the closure strips, sealant and ridge closure trims.

B. Apply butyl tape above and below the foam closure strip and seat the closure strip firmly in the tape to ensure a continuous seal. If any voids exist add butyl caulking and reseat the closure.

C. Place a continuous layer of butyl tape on top of the metal ridge closure trims for the length of the building.

D. Fasten the exterior ridge trim to the metal ridge closure trims, per manufacturer’s recommendations, on center with 1/4 inch by 7/8 inch low profile vibration resistant stitch fasteners.

END OF SECTION 074100
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 RELATED SECTIONS
A. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking
B. Section 074293 "Soffit Panels" for metal panels used in horizontal soffit applications.
C. Section 076200 "Sheet Metal Flashing and Trim" for custom- and site-fabricated sheet metal flashing and trim
D. Section 077100 “Roof Specialties” for roof-edge drainage system

1.3 SUMMARY
A. Section includes standing-seam metal roof panels.

1.4 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 type of panel and accessory.
B. Shop Drawings:
   1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
   2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches (1:10).
C. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.
   1. Include similar Samples of trim and accessories involving color selection.
D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1. Metal Panels: 12 inches (305 mm) long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.
B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
C. Field quality-control reports.
D. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
D. Retain strippable protective covering on metal panels during installation.
1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.10 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.11 WARRANTY

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

1. Failures include, but are not limited to, the following:
   a. Structural failures including rupturing, cracking, or puncturing.
   b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
   a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E 1980.

C. Energy Performance: Provide roof panels that are listed on the EPA/DOE’s ENERGY STAR "Roof Product List" for low or steep-slope roof products.

D. Energy Performance: Provide roof panels according to one of the following when tested according to CRRC-1:
   1. Three-year, aged solar reflectance of not less than 0.55 and emissivity of not less than 0.75.
   2. Three-year, aged Solar Reflectance Index of not less than 64 when calculated according to ASTM E 1980.

E. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:
   1. Wind Loads: As indicated on Drawings.
   2. Other Design Loads: As indicated on Drawings.
   3. Deflection Limits: For wind loads, no greater than 1/240 of the span.

F. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E 1680 at the following test-pressure difference:

G. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 1646 or ASTM E 331 at the following test-pressure difference:

H. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E 2140.

I. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
   1. Uplift Rating: UL 90.

J. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Global’s "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.
   1. Fire/Windstorm Classification: Class 1A- 120.
   2. Hail Resistance: SH.
K. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 STANDING-SEAM METAL ROOF PANELS

A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.

2. Clips: One-piece fixed or Two-piece floating to accommodate thermal movement.
   a. Material: 0.062-inch- (1.59-mm-) thick, stainless-steel sheet.

4. Panel Height: 1.5 inches (38 mm).

B. Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and a flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Basis of design: Berridge Manufacturing Company
   b. Acceptable Manufacturer
      i) AEP-Span
      ii) Firestone Metal Products
      iii) Dimensional Metals, Inc.
      iv) Innovative Metals Co. (IMETCO).
      v) ATAS International, Inc.

2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

   a. Nominal Thickness: 0.040 inch (1.02 mm).
   c. Color: As selected by Architect from manufacturer's full range.
3. Clips: Continuous “Zee-Rib” with vinyl “weatherseal” insert to accommodate thermal movement.
   a. Material: 0.064-inch- (1.63-mm-) nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.

5. Panel Coverage: 16 inches (406 mm).
6. Panel Height: 2.0 inches (51 mm).

2.3 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 40 mils (1.013 mm) thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
   2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.
   3. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Grace Construction Products, a unit of W. R. Grace & Co.; Grace Ice and Water Shield HT.
      b. Henry Company; Blueskin PE200 HT.
      c. Kirsch Building Products, LLC; Sharkskin Ultra SA.
      d. Metal-Fab Manufacturing, LLC; MetShield.
      e. Owens Corning; WeatherLock Metal High Temperature Underlayment.

B. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application

2.4 ROOF INSULATION

A. Polyisocyanurate roof insulation:
   1. Type: Rigid polyisocyanurate closed-cell foam boards, permanently bonded to non-asphaltic glass facing sheets, complying with requirements of ASTM C1289-07, Class 1, Type II.
   2. Face size: Minimum 4'-0" by 4'-0".
   3. Total thickness: +/- 5"; in multiple layers.
   5. Fire hazard classification: FM Class I.
   6. Roof covering classification: UL Classified for installation with Class A roof covering.
   7. Slope for tapered boards: 1/4" minimum per foot, across board width, including valleys.

B. Insulation cover board: Acceptable manufacturer
   1. USG, Securock.
      a. Description: Non-structural, mold-resistant gypsum roof board overlayment, with water-resistant, inorganic core and glass facers each side; face to receive roof membrane shall be factory-primed.
b. Reference standards: Meeting ASTM C1177-06, UL Classified, and FM 1-75 approved.

c. Thickness: 1/2" USG Securock. No larger than 4'-0" by 4'-0" when attached using adhesive or asphalt.

d. Fire resistance: UL Class A.

e. Compressive strength: 500 psi.

2. Georgia-Pacific Gypsum LLC, DensDeck Prime Glass-Mat Faced Gypsum Roof Board.
   a. Thickness: 1/2".
   b. Size: 4'-0" by 8'-0".
      1) Exception: No larger than 4'-0" by 4'-0" when attached using adhesive or asphalt.
   c. Weight: 1.95 psf.
   d. Surfacing: Glass mat.
   e. Flexural strength, parallel (ASTM C473): 80 lbf, minimum.
   g. Permeance (ASTM E96): Not more than 35 perms.
   h. R-Value (ASTM C518): Not less than 0.56.
   k. Surface water absorption (ASTM C473): Not more than 2.5 grams.
   l. Resistance to mold (D 3273): Pass.

3. Firestone Building Products, IsoGard HD high density polyisocyanurate cover board.
   a. Thickness: Minimum 1/2".
   b. Size: 4'-0" wide by 8'-0" long.
      1) Exception: No larger than 4'-0" by 4'-0" when attached using adhesive or asphalt.
   c. Weight: less than 0.375 per square foot.
   d. Surfacing: coated glass facer.
   e. Flexural strength, parallel (ASTM C473): 80 lbf, minimum.
   f. Foot traffic resistance (RLE): not less than 6000 passes.
   g. Flute span (ASTM E661): 2.625 inches.
   h. R-Value (ASTM C518): not less than 2.5.
   i. Water absorption (ASTM C209): not more than 3%.
   j. Compressive strength (ASTM D1621): not less than 120 psi.

C. Insulation fastener system to metal deck; Type required by roofing system manufacturer and meeting characteristics and wind uplift further specified:
   2. Plates: Minimum 3" diameter, non-corrosive material.
   3. Wind uplift: FM wind uplift ratings for locations and heights indicated on drawings.

E. Low-Rise Foam Adhesive:
   1. Single-component Moisture-cured Adhesive: ASTM D-2126, dispensed from portable pressurized containers, such as "Insta-Stik Professional Roofing Adhesive" by Dow Chemical Co. or "I.S.O. Twin Pack Insulation Adhesive" by Firestone.
   2. Coverboard adhesive: OMG, Inc., Olybond 500,

2.5 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C 645; cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z275 hot-dip galvanized) coating designation or
ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads.

E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.

2.6 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

   1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

   2. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.

   3. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.

   4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

   5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

      a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.7 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Panels and Accessories:

   1. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

   2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).
3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.

2. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.

   a. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

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

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.3 INSULATION INSTALLATION

A. Install insulation over entire area to be roofed, mechanically fastened as required by roofing manufacturer.

B. Provide wood nailers at all perimeters of insulation and at other locations where indicated on the drawings, of total height matching the total thickness of insulation being used

   1. Install with 1/8 inch gap between each length and at each change of direction.
   2. Mechanically fasten to deck to resist force of 200 lbf per linear foot.

3.4 INSULATION COVER BOARD INSTALLATION

A. Install cover board in full coverage of specified low rise foam adhesive

   1. Install with joints staggered over insulation one-half board width.
   2. Stagger end joints in adjacent boards one-half board length.
   3. Butt edges for snug contact.
   4. Step into place to ensure full adhesion; do not slide into place.
3.5 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches (152 mm) staggered 24 inches (610 mm) between courses.Overlap side edges not less than 3-1/2 inches (90 mm). Extend underlayment into gutter trough. Roll laps with roller. Cover underlayment within 14 days.

1. Apply over the entire roof area as indicated below:
   a. Roof perimeter for a distance up from eaves of 36 inches (914 mm) beyond interior wall line.
   b. Valleys, from lowest point to highest point, for a distance on each side of 18 inches (460 mm). Overlap ends of sheets not less than 6 inches (152 mm).
   c. Rake edges for a distance of 18 inches (460 mm).
   d. Hips and ridges for a distance on each side of 12 inches (305 mm).
   e. Roof-to-wall intersections for a distance from wall of 18 inches (460 mm).
   f. Around dormers, chimneys, skylights, and other penetrating elements for a distance from element of 18 inches (460 mm).

B. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 076200 "Sheet Metal Flashing and Trim."

3.6 METAL PANEL INSTALLATION

A. General: Install metal panels according to manufacturer’s written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.

C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.
D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

E. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.

   1. Install clips to supports with self-tapping fasteners.
   2. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
   3. Watertight Installation:
      a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
      b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
      c. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.

F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

   1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.

G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

   1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.
   2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

H. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches (914 mm) o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

I. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1524 mm) o.c. in between.
1. Provide elbows at base of downspouts to direct water away from building.
2. Connect downspouts to underground drainage system indicated.

J. Roof Curbs: Install flashing around bases where they meet metal roof panels.

K. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.7 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.

B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.

C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

D. Prepare test and inspection reports.

3.9 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074113.16
SECTION 074293

SOFFIT PANELS

PART 1  GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 RELATED SECTIONS

A. Section 054000 – Cold-Formed Metal framing: Metal framing for support of aluminum soffits.

B. Section 061000 - Rough Carpentry.

C. Section 076200 – Sheet Metal Flashing and Trim.

D. Section 079200 - Joint Sealants.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM)


2. ASTM D 958 - Practice for Determining Temperatures of Standard ASTM Molds for Test Specimens of Plastics.


4. ASTM E136 - Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C

B. American Architectural Manufacturers Association (AAMA)


1.4 SUBMITTALS

1. Product data: submit manufacturer's printed product literature, specifications and data sheet.

2. Submit duplicate 6 inch X 6 inch (152.4mm x 150mm) samples of soffit material, of colour and profile specified.

3. Shop drawings to indicate dimensions, profiles, attachment methods, schedule of wall elevations, trim and closure pieces, soffits, fascia, metal furring, and related work.

4. Certifications: Manufacturer’s certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and standards.

5. Submit manufacturer's installation instructions.

1.5 WARRANTY

1. Provide a written guarantee, signed and issued in the name of the owner, covering the metal cladding/siding material for 15 (fifteen) years from the date of Substantial Completion.

2. The manufacturer's warranty is limited to replacement of defective material only, rather than installation of the same. Faulty installation shall be corrected by the installing contractor. The warranty required herein is the sole remedy against the manufacturer and there are no other implied warranties. In any event, the manufacturer shall not be liable for incidentals or consequential damages.

PART 2 PRODUCTS

2.1 WOOD LOOK ALUMINUM SOFFIT PANELS AND COMPONENTS (AWD-1)

A. 6 inch V-Groove planks extruded aluminum 6063 T5

1. Finish coating: powder coated finish
2. Color: As shown in drawings.
4. Thickness: 0.062 mm base metal thickness.
5. Profile: 6 inch (152.4mm) V-Groove 24 ft (7315.2mm) plank

2.2 ACCESSORIES

A. Exposed trim: inside corners, outside corners, wide starter strip, j-track, Flat-cap and base, U-cap and base, Finishing-cap and base, two-piece corner, perforated 2.5 vent strip, 2.5 non-perforated strip in same material and finishes as siding.

2.3 MANUFACTURERS

A. Mayne Inc. 27575 50Ave Langley, BC Canada V3A 0A2 em. info@longboardproducts.com ph. 1.800.604.0343
PART 3 EXECUTION

3.1 INSTALLATION
   A. Install material in accordance with local building codes, and manufacturer's written instructions
   B. Install soffit and fascia cladding as indicated.
   C. Maintain joints in exterior cladding, true to line, tight fitting, hairline joints.
   D. Attach components in manner not restricting thermal movement.

3.2 CLEANING
   A. Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION 074293
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

B. Wood look aluminum siding

C. Wood look aluminum siding privacy screen

1.3 RELATED SECTIONS

A. Section 054000 – Cold-Formed Metal framing: Metal framing for support of aluminum soffits.

B. Section 061000 - Rough Carpentry.

C. Section 076200 – Sheet Metal Flashing and Trim.

D. Section 079200 - Joint Sealants.

1.4 REFERENCES

A. American Society for Testing and Materials (ASTM)


2. ASTM D 958 - Practice for Determining Temperatures of Standard ASTM Molds for Test Specimens of Plastics.


4. ASTM E136 - Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C

B. American Architectural Manufacturers Association (AAMA)


1.5 SUBMITTALS

A. Product data: submit manufacturer’s printed product literature, specifications and data sheet.

B. Submit duplicate 6 inch X 6 inch (152.4mm x 150mm) samples of siding material, of colour and profile specified.

C. Shop drawings to indicate dimensions, profiles, attachment methods, schedule of wall elevations, trim and closure pieces, soffits, fascia, metal furring, and related work.

D. Certifications: Manufacturer’s certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and standards.

E. Submit manufacturer’s installation instructions.

1.6 WARRANTY

A. Provide a written guarantee, signed and issued in the name of the owner, covering the metal cladding/siding material for 15 (fifteen) years from the date of Substantial Completion.

B. The manufacturer’s warranty is limited to replacement of defective material only, rather than installation of the same. Faulty installation shall be corrected by the installing contractor. The warranty required herein is the sole remedy against the manufacturer and there are no other implied warranties. In any event, the manufacturer shall not be liable for incidentals or consequential damages.

PART 2 - PRODUCTS

2.1 WOOD LOOK ALUMINUM SIDING AND COMPONENTS (AWD-2)

A. 6 inch V-Groove planks extruded aluminum 6063 T5
   1. Finish coating: powder coated finish
   2. Color: As indicated in drawings.
   4. Thickness: 0.062 mm base metal thickness.
   5. Profile: 6 inch (152.4mm) V-Groove 24 ft (7315.2mm) plank

B. 1x5 Beams extruded aluminum 6063 T5
   1. Finish coating: powder coated finish
   2. Color: As indicated in drawings.
   4. Thickness: 0.062 mm base metal thickness.
5. Profile: 1x5 rectangular beam

2.2 ACCESSORIES

A. Exposed trim: inside corners, outside corners, wide starter strip, j-track, Flat-cap and base, U-cap and base, Finishing-cap and base, two-piece corner, perforated 2.5 vent strip, 2.5 non-perforated strip in same material and finishes as siding.

B. Single posts, double posts, mounting brackets, plastic spacers, beam caps, post caps.

2.3 MANUFACTURERS

A. Mayne Inc. 27575 50Ave Langley, BC Canada V3A 0A2 em. info@longboardproducts.com ph. 1.800.604.0343

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cladding in accordance with CGSB 93.5, and manufacturer's written instructions

B. Install wide starter strips, inside and outside corners, edgings, soffit, drip, cap, sill and window/door opening flashings as required.

C. Install outside corners, fillers and closure strips with carefully formed and profiled work.

D. Install soffit and fascia cladding as indicated.

E. Maintain joints in exterior cladding, true to line, tight fitting, hairline joints.

F. Attach components in manner not restricting thermal movement.

3.2 CLEANING

A. Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION 074616
SECTION 075423
THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes the following:
   1. Adhered thermoplastic polyolefin (TPO) roofing system.
   2. Vapor retarder.
   3. Roof insulation.
   4. Cover board
B. This Section includes the installation of acoustical roof deck rib insulation strips furnished under Division 5 Section 053110 "Steel Roof Deck."
C. Related Sections include the following:
   1. Division 5 Section 053110 "Steel Roof Deck" for furnishing acoustical deck rib insulation.
   2. Division 6 Section 061050 "Miscellaneous Carpentry" for wood nailers, curbs, and blocking.
   3. Division 7 Section 079200 "Joint Sealants."

1.3 DEFINITIONS
A. Roofing Terminology: Refer to ASTM D 1079 and glossary of NRCA’s "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.
C. Factored Design Uplift Pressure: The uplift pressure, calculated according to procedures in SPRI's "Wind Load Design Guide for Fully Adhered and Mechanically Fastened Roofing Systems," after multiplication by a safety factor.
1.4 PERFORMANCE REQUIREMENTS

A. General: Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing membrane manufacturer based on testing and field experience.

C. Roofing System Design: Provide a membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE 7, for 120 miles per hour windspeed.

D. FMG Listing: Provide roofing membrane, base flashings, and component materials that comply with requirements in FMG 4450 and FMG 4470 as part of a membrane roofing system and that are listed in FMG's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FMG markings.

E. Roofing System Design: Provide a membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist the factored design uplift pressures calculated according to SPRI's "Wind Load Design Guide for Fully Adhered and Mechanically Fastened Roofing Systems."

1.5 SUBMITTALS

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

B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other Work.
   1. Base flashings and membrane terminations.
   2. Tapered insulation, including slopes.
   3. Insulation fastening patterns.

C. Samples for Verification: For the following products:
   1. 12-by-12-inch (300-by-300-mm) square of sheet roofing, of color specified, including T-shaped side and end lap seam.
   2. 12-by-12-inch (300-by-300-mm) square of roof insulation.
   3. 12-by-12-inch (300-by-300-mm) square of walkway pads or rolls.
   4. 12-inch (300-mm) length of metal termination bars.
   5. 12-inch (300-mm) length of battens.
   6. Six insulation fasteners of each type, length, and finish.
   7. Six roof cover fasteners of each type, length, and finish.

D. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system.
E. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

1. Submit evidence of meeting performance requirements.

F. Qualification Data: For Installer and manufacturer.

G. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of roofing system.

H. Research/Evaluation Reports: For components of membrane roofing system.

I. Maintenance Data: For roofing system to include in maintenance manuals.

J. Warranties: Special warranties specified in this Section.

K. Inspection Report: Copy of roofing system manufacturer's inspection report of completed roofing installation.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty.

B. Manufacturer Qualifications: A qualified manufacturer that has UL listing and FMG approval for membrane roofing system identical to that used for this Project.

C. Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

D. Source Limitations: Obtain components for membrane roofing system from or approved by roofing membrane manufacturer.

E. Fire-Test-Response Characteristics: Provide membrane roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per test method below by UL, FMG, or another testing and inspecting agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.

1. Exterior Fire-Test Exposure: Class A; ASTM E 108, for application and roof slopes indicated.

F. Preinstallation Conference: Conduct conference at Project site. Comply with requirements in Division 1 Section 01312 "Coordination and Meetings." Review methods and procedures related to roofing system including, but not limited to, the following:

1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck
Installer, and installers whose work interfaces with or affects roofing including installers of roof accessories and roof-mounted equipment.

2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.

3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.

5. Review structural loading limitations of roof deck during and after roofing.

6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.

7. Review governing regulations and requirements for insurance and certificates if applicable.

8. Review temporary protection requirements for roofing system during and after installation.

9. Review roof observation and repair procedures after roofing installation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.8 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.
1.9 WARRANTY

A. Special Warranty: Manufacturer’s standard form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks.

1. Special warranty includes roofing membrane, base flashings, roofing membrane accessories, roof insulation, fasteners, cover boards, substrate board, vapor retarder, walkway products and other components of membrane roofing system.
2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 THERMOPLASTIC POLYOLEFIN ROOFING MEMBRANE

A. Reinforced Thermoplastic Polyolefin Sheet: Uniform, flexible sheet formed from a thermoplastic polyolefin, internally fabric or scrim reinforced, and as follows:

1. Manufacturers:
   b. Acceptable manufacturers
      i) Carlisle SynTec Systems
      ii) GAF Materials Corporation
      iii) Johns Manville
      iv) Or Approved Equal by Architect

2. Thickness: 60 mils nominal.
4. Physical Properties:
   a. Sheet Width: Provide the widest available sheets to minimize field seaming.
   b. Puncture Resistance: 265 lbf (1174 N), minimum, when tested in accordance FTM 101C Method 2031
   c. Solar Reflectance: 0.79, minimum, when tested in accordance with ASTM C 1549.
2.3 AUXILIARY MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.

1. Liquid-type auxiliary materials shall meet VOC limits of authorities having jurisdiction.

B. Sheet Flashing: Manufacturer's standard unreinforced thermoplastic polyolefin sheet flashing, 55 mils (1.4 mm) thick, minimum, of same color as sheet membrane.

C. Bonding Adhesive: Manufacturer's standard bonding adhesive for membrane, and solvent-based bonding adhesive for base flashings.

D. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

E. Metal Termination Bars: Manufacturer's standard predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.

F. Metal Battens: Manufacturer's standard aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch (25 mm) wide by 0.05 inch (1.3 mm) thick, prepunched.

G. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.

H. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, termination reglets, cover strips, and other accessories.

2.4 VAPOR RETARDER

A. Polyethylene Vapor Retarder: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).

2.5 ROOF INSULATION

A. General: Provide preformed roof insulation boards that comply with requirements and referenced standards, selected from manufacturer's standard sizes and of thicknesses indicated.

B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, glass-fiber mat facer on underside surfaces and laminate 1/2” cover board on the top surface, minimum of 60 PSI compressive strength.

1. Manufacturers:
   a. GAF Materials Corporation.
b. Rmax Operating, LLC  
c. Duro-Last, Inc.

C. Insulation thickness: +/- Five inches, including the 1/2 inch cover board

D. Long-term thermal resistance (LTTR) R-value in accord with ASTM C1289-12:  
   R-25 for total roof assembly thickness

E. Cover board
   1. Cover board to be approved by roofing membrane manufacturer.
   2. Thickness: Minimum of 1/2-inch.
   3. Maximum cover board size is 4 ft x 8 ft when mechanically attached or attached with  
      either insulation adhesive or hot bitumen.

F. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where  
   indicated for sloping to drain. Fabricate to slopes indicated.

2.6 INSULATION ACCESSORIES

A. General: Roof insulation accessories recommended by insulation manufacturer for intended  
   use and compatible with membrane roofing.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-  
   resistance provisions in FMG 4470, designed for fastening roof insulation to substrate, and  
   acceptable to roofing system manufacturer.

C. Cold Fluid-Applied Adhesive: Manufacturer's standard cold fluid-applied adhesive formulated to  
   adhere roof insulation to substrate.

D. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric mat, water  
   permeable and resistant to ultraviolet degradation, type and weight as recommended by roofing  
   system manufacturer for application.

E. Metal Securement System: Perimeter securement flashing and strapping fabricated from  
   stainless steel, a minimum of 0.031 inch (0.8 mm) thick. Provide fasteners as recommended by  
   mortar-faced insulation manufacturer.

2.7 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting,  
   surface-textured walkway pads or rolls, approximately 3/16 inch (5 mm) thick, and acceptable to  
   membrane roofing system manufacturer.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:

1. Verify that roof openings and penetrations are in place and set and braced and that roof drains are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck comply with requirements in Division 5 Section "Steel Roof Deck."
4. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

D. Comply with roofing manufacturer’s requirements.

3.3 VAPOR-RETARDER INSTALLATION

A. Loosely lay polyethylene-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.

   1. Seal side and end laps with tape.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

3.4 INSULATION INSTALLATION

A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
B. Comply with membrane roofing system manufacturer's written instructions for installing roof insulation.

C. Install tapered insulation under area of roofing to conform to slopes indicated.

D. Install one or more layers of insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 1-1/2 inches (38 mm) or greater, install 2 or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.

E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.

1. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.

G. Mechanically Fastened and Adhered Insulation: Install each layer of insulation and secure first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

1. Fasten first layer of insulation according to requirements in FMG's "Approval Guide" for specified Windstorm Resistance Classification.
2. Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
3. Install subsequent layers of insulation in a cold fluid-applied adhesive.

3.5 COVER BOARD INSTALLATION

A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. Cut and fit cover board tight to nailers, projections, and penetrations.
3. Adhere cover board to substrate using adhesive according to FM Approvals' RoofNav assembly requirements and FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification, as follows:
   a. Set cover board in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place

B. Install slip sheet over cover board and beneath roof membrane
1.1 ADHERED ROOFING INSTALLATION

A. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.

B. Unroll roof membrane and allow to relax before installing.

C. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

D. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer, and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.

E. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.

F. Apply roof membrane with side laps shingled with slope of roof deck where possible.

G. Seams: Clean seam areas, overlap roof membrane, and hot-air weld side and end laps of roof membrane and sheet flashings, to ensure a watertight seam installation
   1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and sheet flashings.
   2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
   3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

H. Spread sealant bed at scupper, and securely seal roof membrane in place.

3.6 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.

B. Apply solvent-based bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply bonding adhesive to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with sheet flashing.

D. Clean seam areas and overlap and firmly roll sheet flashings into the adhesive. Weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.
3.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform roof tests and inspections and to prepare test reports.

B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Architect.

1. Notify Architect or Owner 48 hours in advance of date and time of inspection.

C. Repair or remove and replace components of membrane roofing system where test results or inspections indicate that they do not comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 PROTECTING AND CLEANING

A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates, and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.9 WARRANTY

A. Submit special warranties specified in this Section as a submittal pursuant to article 1.5.J.

END OF SECTION 075423
 SECTION 076200

SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Formed low-slope roof sheet metal fabrications.
   2. Formed wall sheet metal fabrications.

B. Related Requirements:
   1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
   2. Section 075423 "Thermoplastic Polyolefin (TPO) Roofing" for materials and installation of sheet metal flashing and trim integral with roofing.

1.3 COORDINATION

A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.4 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 manufactured product and accessory.

B. Shop Drawings: For sheet metal flashing and trim.

   1. Include plans, elevations, sections, and attachment details.
   2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.
   3. Include identification of material, thickness, weight, and finish for each item and location in Project.
   4. Include details for forming, including profiles, shapes, seams, and dimensions.
5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.

6. Include details of termination points and assemblies.

7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.

8. Include details of roof-penetration flashing.

9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.

10. Include details of special conditions.

11. Include details of connections to adjoining work.

12. Detail formed flashing and trim at scale of not less than 1-1/2 inches per 12 inches.

C. Samples for Initial Selection: For each type of sheet metal and accessory indicated with factory-applied finishes.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1. For copings and roof edge flashings that are SPRI ES-1 tested and FM Approvals approved, shop shall be listed as able to fabricate required details as tested and approved.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. FM Approvals Listing: Manufacture and install copings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, as indicated in PVC roofing section. Identify materials with name of fabricator and design approved by FM Approvals.
D. Manufacture and install copings tested according to SPRI ES-1 and capable of resisting the following design pressure:

1. Design Pressure: As indicated in Drawings.
2. SPRI Wind Design Standard: Tested according to SPRI ES-1,

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Aluminum Sheet: ASTM B 209, T 3003 alloy, as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.

1. Exposed Coil-Coated Finish:
   a. Two-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2. Color: As selected by Architect from manufacturer's full range.
3. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

C. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, dead soft, fully annealed; with smooth, flat or surface.

1. Products: Subject to compliance with requirements, provide one of the following:
   b. STS Coatings, Inc.; Wall Guardian TWF Stainless Steel (www.stscoatings.com).

2. Accessories: Prefabricated corners and end dams, Type 304 stainless steel, 26 gauge (0.0187 inch thickness).

2.3 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
   a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
   b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
3. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

D. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
   1. Sealant shall be compatible with roofing system, waterproofing, air barriers, and other waterproofing and weatherproofing materials

2.4 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.

1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
2. Obtain field measurements for accurate fit before shop fabrication.
3. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
4. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.

D. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard and by FM Global Property Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.
1. Hidden Cleats: Galvanized steel sheet, G90 coating, min. one ga. heavier than material being secured are acceptable.

E. Do not use graphite pencils to mark metal surfaces.

2.5 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Counterflashing, Equipment Support Counterflashings and Roof Penetration Flashings: Shop fabricate interior and exterior corners. Fabricate from the following materials:
   1. Aluminum: Min. 0.050 inch thick.

2.6 WALL SHEET METAL FABRICATIONS

A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch-long, but not exceeding 12-foot-long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings; and form with 2-inch-high, end dams. Fabricate from the following materials:
   1. Stainless Steel: 0.016 inch thick.
   2. Joinery: Comply with York manufacturing instructions. Flashing must be butted together over a 12-inch wide splice piece of York Multi-Flash 500 or double sided butyl tape and sealed with UniverSeal. (Overlapping is not an acceptable practice with drainage plane flashing.)
   3. Corners and End Dams: Fabricated per Comply with York manufacturing instructions as submitted and approved. Furnish prefabricated units to extent practical.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.

   1. Verify compliance with requirements for installation tolerances of substrates.
   2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
   3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

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

3.2 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.

2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

3. Space cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.

4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.

5. Torch cutting of sheet metal flashing and trim is not permitted.

6. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

1. Coat concealed side of uncoated-aluminum sheet metal flashing and trim with elastomeric coating or sheets where flashing and trim contact wood, ferrous metal, or cementitious construction.

2. Elastomeric coatings shall be compatible with roof membrane.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.

2. Use lapped expansion joints only where indicated on Drawings.

D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction.

1. Use sealant-filled joints unless otherwise indicated. Embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.

2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."
3.3 ROOF FLASHING INSTALLATION

A. General: Install sheet metal flashing and trim to comply with performance requirements and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Copings: Anchor to resist uplift and outward forces according to recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for specified FM Approvals’ listing for required windstorm classification.

C. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.

D. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints minimum of 4 inches. Secure in waterproof manner by means of anchor and washer at 36-inch centers unless otherwise indicated.

E. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.4 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.5 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean off excess sealants.

C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer’s written installation instructions. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended by sheet metal flashing and trim manufacturer. Maintain sheet metal flashing and trim in clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD's Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Roof-edge drainage systems.

B. Related Requirements:

1. Section 055000 "Miscellaneous Metal" for downspout guards and downspout boots.
2. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
3. Section 074113.16 "Standing-Seam Metal Roof Panels" for roof-edge drainage-system components provided by metal-roof-panel manufacturer.
4. Section 076200 "Sheet Metal Flashing and Trim" for custom- and site-fabricated sheet metal flashing and trim.
5. Section 079200 "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.

C. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, roofing-system testing and inspecting agency representative, roofing Installer, roofing-system manufacturer's representative, Installer, structural-support Installer, and installers whose work interfaces with or affects roof specialties, including installers of roofing materials and accessories.
2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
3. Review special roof details, roof drainage, and condition of other construction that will affect roof specialties.

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.
B. Shop Drawings: For roof specialties.

1. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work.
2. Include details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
3. Indicate profile and pattern of seams and layout of fasteners, cleats, clips, and other attachments.
4. Detail termination points and assemblies, including fixed points.
5. Include details of special conditions.

C. Samples: For each type of roof specialty and for each color and texture specified.

D. Samples for Initial Selection: For each type of roof specialty indicated with factory-applied color finishes.

E. Samples for Verification:

1. Include Samples of each type of roof specialty to verify finish and color selection, in manufacturer's standard sizes.
2. Include roof-edge drainage systems made from 12-inch (300-mm) lengths of full-size components in specified material, and including fasteners, cover joints, accessories, and attachments.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Product Certificates: For each type of roof specialty.

C. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing specialties to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer offering products meeting requirements that are FM Approvals listed for specified class and SPRI ES-1 tested to specified design pressure.

B. Source Limitations: Obtain roof specialties approved by manufacturer providing roofing-system warranty.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.
1.8 FIELD CONDITIONS

A. Field Measurements: Verify profiles and tolerances of roof-specialty substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.

B. Coordination: Coordinate roof specialties with flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.9 WARRANTY

A. Roofing-System Warranty: Roof specialties are included in warranty provisions of the roofing specifications.

B. Special Warranty on Painted Finishes: Manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.

   1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

   2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof specialties shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. FM Approvals' Listing: Manufacture and install roof-edge specialties that are listed in FM Approvals' “RoofNav” and approved for windstorm classification, Class 1-90. Identify materials with FM Approvals' markings.

C. SPRI Wind Design Standard: Manufacture and install roof-edge specialties tested according to SPRI ES-1 and capable of resisting the following design pressures:

   1. Design Pressure: As indicated on Drawings.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that
resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 ROOF-EDGE DRAINAGE SYSTEMS

A. Gutters: Formed from material specified below, complete with end pieces, outlet tubes and other special pieces as required. Fabricate in full length of roof edge without any seams. Furnish flat-stock gutter straps, gutter brackets fabricated from same metal as gutters.

1. Aluminum Sheet: 0.050 inch (1.27 mm) thick.
2. Gutter Profile: Rectangular and as indicated according to SMACNA's "Architectural Sheet Metal Manual."
4. Gutter Supports: Manufacturer's standard supports as selected by Architect with finish matching the gutters. Furnish gutter supports spaced a maximum of 36 inches o.c.
5. Gutter Accessories: Continuous screened leaf guard with sheet metal frame.

B. Downspouts: Plain rectangular complete with mitered elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.

1. Formed Aluminum: 0.050 inch (1.27 mm)] [0.063 inch (1.60 mm) thick.

C. Parapet Scuppers: Manufactured with closure flange trim to exterior, 4-inch- (100-mm-) wide wall flanges to interior, and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof.

1. Stainless Steel: 0.019 inch (0.48 mm) thick.

D. Aluminum Finish: Three-coat fluoropolymer.

1. Color: As selected by Architect from manufacturer's full range.

E. Stainless-Steel Finish: No. 4 (bright, polished directional satin).

2.3 MATERIALS

A. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.

B. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.

2.4 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet: Minimum 40 to 60 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

1. Grace: "Water and Ice Shield"

2.5 MISCELLANEOUS MATERIALS

A. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:

1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
2. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.
3. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.

B. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane or silicone polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.

2.6 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Coil-Coated Aluminum Sheet Finishes:

1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   b. Concealed Surface Finish: Apply pretreatment and manufacturer's standard acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.

C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage where applicable, and securely anchored.

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

3.2 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches (152 mm) staggered 24 inches (610 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.

1. Apply continuously under roof-edge specialties.
2. Coordinate application of self-adhering sheet underlayment under roof specialties with requirements for continuity with adjacent air barrier materials.

3.3 INSTALLATION, GENERAL

A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete roof-specialty systems.

1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
2. Provide uniform, neat seams with minimum exposure of solder and sealant.
3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
4. Torch cutting of roof specialties is not permitted.
5. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum and stainless-steel roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.


1. Space movement joints at a maximum of 12 feet (3.6 m) with no joints within 18 inches (450 mm) of corners or intersections unless otherwise indicated on Drawings.
2. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.
D. Fastener Sizes: Use fasteners of sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Seal concealed joints with butyl sealant as required by roofing-specialty manufacturer.

F. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F (4 deg C).

G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm); however, reduce pre-tinning where pre-tinned surface would show in completed Work. Tin edges of uncoated copper sheets using solder for copper. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

3.4 ROOF-EDGE DRAINAGE-SYSTEM INSTALLATION

A. General: Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.

B. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 12 inches (305 mm) apart. Attach ends with rivets and seal with sealant to make watertight. Slope to downspouts.

1. Install gutter with expansion joints at locations indicated but not exceeding 50 feet (15.2 m) apart. Install expansion-joint caps.
2. Install continuous leaf guards on gutters with noncorrosive fasteners, removable for cleaning gutters.

C. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1500 mm) o.c.

1. Provide elbows at base of downspouts at grade to direct water away from building.
2. Connect downspouts to underground drainage system indicated.

D. Parapet Scuppers: Install scuppers through parapet where indicated. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.

1. Anchor scupper closure trim flange to exterior wall and seal or solder to scupper.
2. Loosely lock front edge of scupper with conductor head.
3. Seal or solder exterior wall scupper flanges into back of conductor head.

3.5 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
B. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.

C. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077100
SECTION 079200

JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Urethane joint sealants.
3. Mildew-resistant joint sealants.
4. Latex joint sealants.

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-(13-mm)-wide joints formed between two 6-inch-(150-mm)-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

C. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.

1.4 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following:

   1. Sealants and sealant primers for nonporous substrates shall have a VOC content of 250 g/L or less.

C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.

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

      a. Dow Corning Corporation.; 791
      b. GE Construction Sealants; SCS2000 Silpruf
      c. Pecora Corporation, PCS
      d. Sika Corporation US; Sikasil WS-295

B. Silicone, Paintable, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT, paintable.

   1. Products: Subject to compliance with requirements, provide the following where exterior joints are finished with acrylic paints:

      a. Momentive Performance Materials, Inc. ; GE 7000, GE Silicone II Paintable Sealant

2.3 URETHANE JOINT SEALANTS

A. Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent minimum movement capability, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.

   1. Products: Subject to compliance with requirements, provide one of the following:
2.4 MILDEW-RESISTANT JOINT SEALANTS

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.

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

   a. Dow Corning Corporation; DOW CORNING® 786 SILICONE SEALANT -.
   b. GE Construction Sealants; Momentive Performance Materials Inc; SCS1700 Sanitary.
   c. Tremco Incorporated; Tremsil 200.

2.5 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

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

   b. Sherwin-Williams Company (The); PowerHouse Siliconized Acrylic Latex Sealant.
   c. Tremco Incorporated; Tremflex 834.

2.6 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.
2.7 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

   a. Concrete.
   b. Masonry.

3. Remove laitance and form-release agents from concrete.

4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

   a. Metal.
   b. Glazed surfaces of ceramic tile.
3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer’s written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.
   3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.
3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE


1. Joint Locations:
   a. Interior and exterior joints.
   b. Exposed perimeter joints between wall materials and frames of doors, windows, and louvers.
   c. Control and expansion joints in unit masonry.
   d. Perimeter joints between materials listed above and frames of doors and louvers.
   e. Other joints as indicated on Drawings.

2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.
   a. At interior (roof) side of parapet, provide silicone or urethane sealant compatible with roof system and fluid-applied membrane air barrier.
   b. Where exterior painted joints are indicated, provide paintable silicone sealant or urethane sealant.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

B. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces

1. Joint Locations:
   a. Control and expansion joints on exposed interior surfaces of exterior walls.
   b. Vertical joints on exposed surfaces of unit masonry, concrete, and walls.
   c. Joints on interior (roof) side of concrete parapet panels planks.
   d. Tile control and expansion joints.
   e. Concealed wall drainage membranes and flashing. Use silicone sealants at this location if compatibility is better.
   f. Other joints as indicated on Drawings.

2. Joint Sealant: Urethane, S, NS, 35, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
C. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.

1. Joint Locations:
   a. Perimeter joints between interior wall surfaces and frames of interior doors and windows.
   b. Other joints as indicated on Drawings.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

D. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:
   a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
   b. Tile control and expansion joints where indicated.

2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 079200
PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Steel doors and frames.
   2. Glazed light frames.
   3. Preparation for door hardware.

B. Products Supplied But Not Installed Under This Section
   1. Division 04 Section 042200 "Concrete Unit Masonry" for frame anchors.

C. Related Sections:
   1. Division 04 Section 042200 "Concrete Unit Masonry" for grouting and filling of frames.
   2. Division 08 Section 087100 "Door Hardware."
   3. Division 08 Section 088000 "Glazing."
   4. Coordinate with security/card access system and fire alarm system if applicable.

1.3 REFERENCES

D. General:
   1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
   2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.

E. ASTM International:
   1. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process


G. CBC Standard 7-4: Fire Test of Window Assemblies.

H. HMMA 850: Fire Rated Hollow Metal Doors and Frames.


M. NFPA 257-1990: Standard Fire Test for Window and Glass Block Assemblies.


O. UL Standard 10C: Positive Pressure Fire Tests of Door Assemblies.

P. Submit under provisions of TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

Q. Product Data: Manufacturer's product literature, specifications and installation instructions.

R. Shop Drawings: Indicate door and frame elevations, dimensions, fire rating, door type, core, reinforcement, finish, hardware locations, cutout locations, frame profiles, details, metal gage, anchorage details, and finish.

S. Schedule: Schedule of doors and frames, using same reference numbers for details and openings as those on Drawings. Indicate frame and door types.

T. Deliver, store and handle steel doors and frames in a manner to prevent damage and deterioration.

U. Storage: Comply with HMMA 840 and manufacturer’s recommendations.

PART 2 - PRODUCTS

MANUFACTURERS

A. Typical: Ceco Door Products, Forderer Cornice Works, Fenestra Corporation, or Steelcraft Ingersoll-Rand.

MATERIALS:
B. Doors: HMMA 861 Type A, 1-3/4" thick, full flush continuously welded edge seams with no visible seams on faces or vertical edges, steel stiffened core, insulated with inorganic, noncombustible material.

1. Exterior Doors: ASTM A653 hot-dip galvanized sheet steel, 16 gage (0.0538 inches minimum) unless otherwise noted.

2. Interior Doors: 18 gage sheet steel (0.0428 inches minimum) unless otherwise noted.

3. Glazing: Comply with Division 08 Section 088000 "Glazing".

4. Stile And Rail Doors: 16 gage sheet steel unless noted otherwise, formed into rectangular tubes with integral formed stop, continuously welded to form a rigid tubular frame, welds ground smooth and flush.

C. Frames: HMMA 861.


2. Interior Frames: Welded type.

3. Gage: Minimum 16 gage for openings 4 feet (1.2 m) in width or less; 14 gage for openings greater than 4 feet (1.2 m) in width.

4. Door Silencers: Resilient type, fitted in drilled holes, removable for replacement.

5. Mortar Guard Boxes: Minimum 22 gage, welded in place; provide where frames may be grouted.

D. Fire Rated Doors, Frames and Glazed Light Frames:

1. Labels: UL or Warnock-Hersey labels for the exposures indicated.
   a. Items provided with labels other than the fire resistive rating shown on the Door Schedule are not permitted and will be rejected.
   b. If any item noted to be fire rated cannot qualify for appropriate labeling, obtain instructions from the Project Manager before beginning fabrication on that item.
   c. All Fire Rated Doors shall be pre-cored on the hinge side, 3/8" diameter to the lock for installation of access control device. The center hinge must match center-to-center for transfer installation at the core.

FABRICATION

E. Conform to requirements of NAAMM, except as specified otherwise in this Section.

F. Hardware Preparation: Reinforce and prepare doors and frames to receive hardware furnished under Division 08 Section "Door Hardware".

1. Minimum Gages for Hardware Reinforcing Plates: Provide in accordance with HMMA 861, except hinge and pivot reinforcements shall be 7 gage minimum.

2. Locations for Reinforcing Hardware: Comply with Division 08 Section “Door Hardware”.

3. Consult with Glenn Skipper, ext. 6125, and Pat DuPont, ext. 7668, on the following paragraph. Omit par. if not applicable.
HOLLOW METAL DOORS AND FRAMES

4. Electrical Hardware and Devices: Prepare doors and frames to receive electrical hardware specified in Division 08 Section "Door Hardware"

G. Frames:

2. Knocked Down Frames: Accurately form and miter interlocking joints of knocked down frames to maintain hairline alignment of parts when field assembled.

3. Head Reinforcement: Reinforce frames wider than 4'-0" with two 12 gage minimum formed steel channels welded in place, flush with top of frames.

4. Door Silencers:
   a. Prepare frames for silencers.
   b. Provide 3 silencers on strike jamb of single door frames [and 3 silencers each strike jamb of double door frames with removable mullions. Provide 2 silencers on head of double door frames without removable mullions. Omit silencers at gaskets.

5. Jamb Anchors: Provide per HMMA. Weld floor jamb anchors in place.

H. Fire Rated Labels: Place where visible when doors and frames are in open, installed position.

I. Finish: Comply with requirements of Division 09 Section 099000 “Paints and Coatings” - for primer, including application and compatibility with specified finishes.

   1. Interior Units: Chemically treat surfaces and apply one coat of primer.
   2. Exterior Units: Hot-dipped galvanized in compliance with ASTM A623. Phosphatize or surface treat after galvanizing, and apply one coat of primer.

PART 3 - EXECUTION

COORDINATION

A. Coordinate door and frame and glazed light frames fabrication and installation with Division 08 Section "Door Hardware", including electrified hardware Division 08 Section 0880000 "Glazing"

B. Coordinate door and frame fabrication with security/card access and fire alarm items in Division 16 if applicable.

C. Coordinate setting of steel frames and anchor placement with wall construction.

INSTALLATION

D. Install doors and frames and glazed light frames in accordance with HMMA 840 and with manufacturer's recommendations and instructions.

E. In addition, install fire-rated doors and frames in accordance with NFPA 80 and the manufacturer's fire test report installation data.
F. Remove and replace doors and frames damaged during delivery, storage, installation and construction.

1. Paste filler repair is not permitted.

2. Touch up scratched paint surfaces after installation.

G. Protection: Protect metal surfaces after installation. At Substantial Completion, doors and frames shall be without indication of use, deterioration, or damage.

END OF SECTION 081113
SECTION 081613

FIBERGLASS-REINFORCED PLASTIC DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

B. This section includes the following:
   1. Fiberglass reinforced plastic (FRP) doors
   2. Fiberglass resin transfer molded door frames

1.3 RELATED SECTIONS

A. Related sections include the following:
   1. Section 087100 “Door Hardware”.

1.4 PERFORMANCE REQUIREMENTS

A. Door Properties: Test certification by independent and accredited laboratories is required for the properties listed in this Quality Assurance section. Reports shall be made available upon request for each of the standards and certifications described below:

B. TDI Product Evaluation: Comply with Texas Department of Insurance requirements for wind-resistant doors, including TDI Product Evaluation DR-82.
   1. Provide exterior doors capable of resisting 70 pounds sq. ft. (3350 pa) positive and negative wind pressure.
   2. Interior doors shall be constructed in the same manner as exterior doors.

C. Durability: Successfully completed 1,000,000 cycles testing in accordance with the following:
   3. NWWDA TM-7 Test Method to Determine the Physical Endurance of Wood Doors and Associated Hardware under Accelerated Operating Conditions.

D. Mechanical and Physical Properties:
   2. ASTM D 1761 Mechanical Properties of Fasteners: 1530 lb.
3. ASTM D 638 Tensile Strength Properties of Plastics
4. ASTM D 790 Flexural Strength Properties of Plastics: 39,000 psi.
5. ASTM D 2583 Indentation Hardness of Plastics: 53.
6. ASTM D 256 Izod Pendulum Impact Resistance
7. ASTM D 792 Density/Specific Gravity of Plastics
8. ASTM E 84 Surface Burning Characteristics of Materials
9. ASTM G 155 Xenon Light Exposure of Non Metallic Materials
10. ATSM D 635 Method For Rate of Burning
11. ASTM D 2843 Smoke Density
12. ASTM D 1929 Self Ignition Temperature Properties

E. Core Properties
1. ASTM C 177 Thermal Properties of Materials
2. ASTM D 1622 Density and Specific Gravity
3. ASTM E 84 Surface Burning Characteristics of Materials
4. ASTM E90-04- Sound Transmission Loss
5. ASTM E413-04 Classification for Rating Sound Insulation
6. ASTM E1332-90 Standard Classification for Determination of Outdoor-Indoor Transmission Class
7. ASTM E2235-04 Standard Test for Determination of Decay Rates for Use in Sound Insulation Methods

F. Accessories: Deterioration of curb, sealants and other materials beyond normal weathering is not acceptable.

G. Laminate Properties: Door face plate is a minimum of 0.125 inch thick fiberglass reinforced plastic molded into one continuous sheet starting with a 25 mil resin-rich gelcoat layer resin integrally molded with multiple layers of 1.5 oz. sq. ft. fiberglass mat and one layer of 18 oz. per square yard fiberglass woven roving saturated with special resin. Door plate weight shall not be less than 0.97 lbs per square foot at a ratio of 30/70 glass resin.

H. Laminated plate by itself evaluated in accordance with Florida Building Code TAS 201 Large Missile Impact Test as per ASTM-1996-05b, Standard Specification for Performance of Exterior Windows, Curtain Wall, Doors and Storm Shutters Impacted by Windborne Debris in Hurricanes. The missile (a 2 x 4 with a weight of 9 lbs shot from a cannon at a velocity of 50 ft/sec) did not penetrate the door face plate.

1.5 QUALITY ASSURANCE

I. Manufacturer Qualifications: A company specialized in the manufacture of fiberglass reinforced plastic (FRP) doors and frames as specified herein with a minimum of 30 years documented experience and with a record of successful in-service performance for the applications as required for this project.

J. Installer Qualifications: An experienced installer who has completed fiberglass door and frame installations similar in material, design, and extent to those indicated and whose work has resulted in construction with a record of successful in-service performance.

K. Material Source Limitations: Obtain fiberglass reinforced plastic doors and resin transfer molded fiberglass frames through one source fabricated from a single manufacturer, including fire rated
fiberglass frames. This ensures complete uniformity of physical properties and consistency in the resin chemistry tailored for this application.

L. Hardware Source Limitations: Hardware and accessories for all FRP doors as specified in Section 087100 shall be provided and installed by the fiberglass door and frame manufacturer.

1.6 SUBMITTALS

M. Product technical data including:
   1. Acknowledgment that products submitted meet requirements of standards referenced.
   2. Manufacturer shall provide certificate of compliance with current local and federal regulations as it applies to the manufacturing process.
   3. Manufacturer’s installation instructions.
   4. Schedule of doors and frames indicating the specific reference numbers used on the owner’s project documents, noting door type, frame type, size, handing and applicable hardware.
   5. Details of core and edge construction, including factory construction specifications.
   6. Certification of manufacturer’s qualifications.

N. Submittal drawings shall be submitted prior to manufacture and will include the following information:
   1. Summary door schedule indicating the specific reference numbers as used on owner’s drawings, with columns noting door type, frame type, size, handing, accessories and hardware.
   2. A drawing depicting front and rear door elevations showing hardware with bill of material for each door.
   3. Drawing showing dimensional location of each hardware item and size of each door.
   4. Individual part drawing and specifications for each hardware item and FRP part or product.
   5. Construction and mounting detail for each frame type.

O. Samples:
   1. Provide one complete manufactured door sample which represents all aspects of the typical manufacturing process, including molded in gelcoat color and face plate construction. One edge should expose the interior of the door depicting the unique u-shaped continuous piece stile and rail, hardware reinforcement and core material.

P. Operation and Maintenance Manual
   1. Include recommended methods and frequency for maintaining optimum condition of fiberglass doors and frames under anticipated traffic and use condition.
   2. Include one set of final as built drawings with the same requirements as mentioned in Section B above.
   3. Include certificate of warranty for door and frame listing specific door registration numbers.
   4. Include hardware data sheets and hardware manufacturer’s warranties.

1.2 DELIVERY, STORAGE, AND HANDLING

A. Each door and frame shall be delivered individually crated for protection from damage in cardboard containers, clearly marked with project information, door location, specific reference number as shown on drawings, and shipping information. Each crate shall contain all fasteners necessary for installation as well as complete installation instructions.
B. Doors shall be stored in the original container on edge, out of inclement weather for protection against the elements.

C. Handle doors pursuant to the manufacturer's recommendations as posted on outside of crate.

1.3 WARRANTY

A. All fiberglass doors and frames have a lifetime guarantee against failure due to corrosion. Additionally, fiberglass doors and fiberglass frames are guaranteed for ten years against failure due to materials and workmanship, including warp, separation or delamination, and expansion of the core.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the contract documents, the following manufacturers are acceptable:
   1. Basis of design: Chem-Pruf Door Co., Ltd.
   2. Corrim Company.
   3. Corrosion Guard Products, Corguard.

2.2 FRP DOORS

A. Doors: Fabricate using fiberglass reinforced plastic (FRP) using Class 1 premium resin. Doors shall be 1 ¾ inch thick and of flush construction, having no seams or cracks. All doors up to 35-3/4” x 93-1/8” shall have equal diagonal measurements. For consistency in the resin chemistry tailored for this application and to maintain the same physical properties throughout the structure, all fiberglass components including face plates, stiles and rails and frames must be fabricated by the same manufacturer. Components obtained through various outside sources for plant assembly will not be accepted.

B. Door Plate: Fabricate 0.125 inch thick minimum, molded in one continuous piece, starting with 25 mil gelcoat of the color specified, integrally molded with multiple layers of 1.5 ounces per square foot fiberglass mat and one layer of 18 ounce per square yard fiberglass woven roving. Each layer shall be individually laminated with resin as mentioned above. Door plate weight shall not be less than 0.97 lbs per square foot at a ratio of 30/70 glass to resin. Plate alone to withstand Large Missile Impact per FBC TAS 201. Face plates manufactured using the pultrusion process will not be acceptable. Pultruded plates do not allow for a smooth molded gelcoat finish, do not use woven roving for adequate plate thickness, strength and weight, and do not provide an appropriate glass to resin ratio and will not meet the quality standards of this project.

C. Stiles and Rails: Construct with a matrix of at least three layers of 1.5 ounce per square foot of fiberglass mat. The stile and rail shall be molded in one continuous piece to a U-shaped configuration and to the exact dimensions of the door. In this manner there will be no miter joints and disparate materials used to form the one-piece stile and rail.
D. Core Material: Polypropylene plastic honeycomb core with a non woven polyester veil for unparalleled plate bonding, 180 PSI typical compression range.

E. Internal Reinforcement shall be a dense matrix of cloth glass fibers and premium resin with a minimum hinge screw holding value of 1000 lbs. per screw.

F. Finish of door frame shall be identical with 25 mil resin-rich gelcoat of the specified color integrally molded in at time of manufacture resulting in a smooth gloss surface that is dense and non-porous. To achieve optimum surface characteristics, the gelcoat shall be cured within a temperature range of 120°F to 170°F creating an impermeable outer surface, uniform color throughout, and a permanent homogeneous bond with the resin/fiberglass substrate beneath. Only the highest quality gelcoat will be used to ensure enduring color and physical properties. Paint and/or post application of gelcoat result in poor mechanical fusion and will be deemed unacceptable for this application. The finish of the door and frame must be field repairable without compromising the integrity of the original uniform composite structure, function or physical strength.

H. Louver Openings: Completely sealed, so that the interior of the door is not exposed to the environment. Louvers shall be solid fiberglass “V” Vanes and shall match the color and finish of the door plates.

1. Louver Cover shall be identical to door skin in finish, construction, materials, thickness and reinforcement and shall be installed as per TDI and FBC approved installation instructions provided by the manufacturer.

2. Transoms shall be identical to the doors in finish, construction, materials, thickness and reinforcement and shall be installed as per TDI and FBC approved installation instructions provided by the manufacturer.

3. Doors and Louvers shall meet TDI and FBC requirements pursuant to SFBC PA 201/ SFBC PA 202/ SFBC PA 203/ SFBC 3603.2, 300 lb. tests.

2.3 FRP FRAMES

A. Frames (rated and non-rated): Provide fiberglass substrate, manufactured using the resin transfer method creating one solid piece (no voids) with complete uniformity in color and size. Beginning with a minimum 25 mil gelcoat layer molded in and a minimum of two layers of continuous strand fiberglass mat saturated with resin, the frame will be of one-piece construction with molded stop. All frame profiles shall have a core material of 2 psf polyurethane foam. Metal frames or pultruded fiberglass frames will not be accepted.

B. Finish: Shall be identical to the door with 25 mil resin-rich gelcoat of the specified color integrally molded in at time of manufacture. To achieve optimum surface characteristics, the gelcoat shall be cured within a temperature range of 120°F to 170°F creating an impermeable outer surface, uniform color throughout, and a permanent homogeneous bond with the resin/fiberglass substrate beneath. Only the highest quality gelcoat will be used to ensure enduring color and physical properties. Paint and/or post application of gelcoat result in poor mechanical fusion and will be deemed unacceptable for this application. The finish of the door and frame must be field repairable without compromising the integrity of the original uniform composite structure, function or physical strength.

C. Jamb/Header: connection shall be mitered for tight fit. Optional seamless one piece frame construction as indicated on the project schedules and related details.
D. Internal Reinforcement: shall be continuous within the structure to allow for mounting of specified hardware. Reinforcing material shall be a dense matrix of cloth glass fibers and premium resin with a minimum hinge screw holding value of 1000 lbs per screw. All reinforcing materials shall be completely encapsulated. Documented strength of frame screw holding value after third insert must be submitted. Dissimilar materials, such as steel, will be deemed unacceptable as reinforcement for hardware attachment.

E. Mortises: for hardware shall be accurately machined by CNC to hold dimensions to +/- 0.010 inch in all three axis.

F. Hinge Pockets: shall be accurately machined by CNC to facilitate heavy duty hinges at all hinge locations, using shims when standard weight hinges are used.

G. Frames shall meet TDI requirements per DR-82 and FBC requirements pursuant to SFBC PA 201/ SFBC PA 202/ SFBC PA 203/ SFBC 3603.2.

2.4 HARDWARE

A. See Section 087100.

B. The special nature of this material requires that all related hardware as specified must be furnished and installed by the door frame manufacturer to maintain product quality and function as well as to ensure sufficient support/reinforcement, precision tooling and proper sealing methods are provided.

PART 3 – EXECUTION

3.1 INSTALLATION CONDITIONS

A. Verification of Conditions:
   1. Verify openings are correctly prepared to receive doors and frames.
   2. Verify openings are correct size and depth in accordance with submittal drawings.

B. Installer’s Examination
   1. Door installer shall examine conditions under which construction activities of this section shall be performed and submit a written report to general contractor if conditions are unacceptable.
   2. General Contractor shall submit two copies of the installer’s report to the architect within 24 hours of receipt.
   3. Installer shall not proceed with installation until all unacceptable conditions have been corrected.

3.2 INSTALLATION

A. Door shall be delivered at job site individually crated. Each crate shall be clearly marked with the specific opening information for quick and easy identification.
B. All single doors shall be shipped completely assembled in the frame with hardware installed. Double doors shall be prehung at the factory to ensure a proper fit and that hardware functions properly, then broken down for shipping purposes.

1. If door unitization and pre-hanging is not provided by manufacturer, installation of door and frame systems should be made by a professional hardware installer, certified by a nationally recognized door hardware entity.

C. Install door opening assemblies in accordance with shop drawings and manufacturer’s printed installation instructions, using installation methods and materials specified in installation instructions.

D. Field alteration of doors or frames to accommodate field conditions is strictly prohibited.

E. Site Tolerances: Maintain plumb and level tolerance specified in manufacturer’s printed installation instructions.

F. Louver Cover and Transom: Install in accordance with TDI and FBC approved installation instructions provided by the manufacturer.

3.3 ADJUSTING

A. Adjust doors in accordance with the door manufacturer’s maintenance instructions to swing open and shut without binding and to remain in place at any angle without being moved by gravitational influence.

B. Adjust door hardware to operate correctly in accordance with hardware manufacturer’s maintenance instruction.

3.4 CLEANING

A. Clean surfaces of door opening assemblies and exposed door hardware in accordance with respective manufacturer’s maintenance instructions.

3.5 PROTECTION OF INSTALLED PRODUCTS

B. Protect door opening assemblies and door hardware from damage by subsequent construction activities until final inspection.

END OF SECTION 081613
SECTION 082120

STILE AND RAIL WOOD DOORS

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Interior stile and rail wood doors.
2. Finishing stile and rail wood doors.
3. Fitting stile and rail wood doors to frames and machining for hardware.

B. Related Requirements:

1. Division 8 Section 084110 “Aluminum Framed Entrances and Curtain Wall” and 088000 “Glazing”

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include details of construction and glazing.
2. Include factory-finishing specifications.

B. Shop Drawings: For stile and rail wood doors. Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data, including those for stiles, rails, panels, and moldings (sticking); and other pertinent data., including the following:

1. Dimensions of doors for factory fitting.
2. Locations and dimensions of mortises and holes for hardware.
3. Undercuts.
4. Requirements for veneer matching.
5. Doors to be factory finished and finish requirements.

C. Samples for Initial Selection: For factory-finished doors.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of door, from manufacturer.

B. Sample Warranty: For special warranty.
C. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body and is a certified participant in AWI's Quality Certification Program.

B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in opaque plastic bags or cardboard cartons.

C. Mark each door on bottom rail with opening number used on Shop Drawings.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.

B. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity between 43 and 70 percent during remainder of construction period.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship, or have warped (bow, cup, or twist) more than 1/4 inch (6.4 mm) in a 42-by-84-inch (1067-by-2134-mm) section, within specified warranty period.

1. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.

2. Warranty shall be in effect during the following period of time from date of Substantial Completion:

   a. Interior Doors: 10 Years.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of stile and rail wood door from single manufacturer.

2.2 MATERIALS

A. General: Use only materials that comply with referenced standards and other requirements specified.

1. Assemble interior doors, including components, with either dry-use or wet-use adhesives complying with ASTM D 5572 for finger joints and with ASTM D 5751 for joints other than finger joints.

B. Low-Emitting Materials: Fabricate doors with adhesives and composite wood products that do not contain urea formaldehyde.

C. Low-Emitting Materials: Fabricate doors with adhesives that comply with the testing and product requirements of the California Department of Health Services’ "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Safety Glass: Provide products complying with testing requirements in 16 CFR 1201, for Category II materials, unless those of Category I are expressly indicated and permitted.

1. Glazing: As indicated (RE: Selection 08800 “Glazing”).

2.3 INTERIOR STILE AND RAIL WOOD DOORS


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

   a. Belentry Doors LLC.
   b. International Door and Latch.
   c. JELD-WEN, Inc.
   d. Karona, Inc.
   e. QSM Enterprise, Inc.
   f. (Basis of Design) Simpson Door Company: 1596 - Pantry.

2. Finish and Grade: Clear transparent and premium grade.
3. Wood Species: Clear Maple.
5. Molding Profile (Sticking): Square edges.
6. Glass: Satin etch glass, made from one lite of 3.0-mm-thick annealed glass complying with Section 088000 "Glazing."

7. Mark, label, or otherwise identify stile and rail wood doors as complying with WDMA I.S.6 and grade specified.

### 2.4 STILE AND RAIL WOOD DOOR FABRICATION

**A.** Fabricate stile and rail wood doors in sizes indicated for field fitting.

**B.** Factory fit doors to suit frame-opening sizes indicated, with the following uniform clearances and bevels unless otherwise indicated:

1. **Clearances:** Provide 1/8 inch (3 mm) at heads, jambs, and between pairs of doors. Provide 1/2 inch (13 mm) from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide not more than 3/8 inch (10 mm) from bottom of door to top of threshold.
   
   a. Comply with NFPA 80 for fire-rated doors.

2. Bevel non-fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock and hinge edges.

3. Bevel fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) on lock edge; trim stiles and rails only to extent permitted by labeling agency.

**C.** Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.

1. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.

**D.** Glazed Openings: Trim openings indicated for glazing with solid wood moldings, with one side removable. Miter wood moldings at corner joints.

**E.** Glazed Openings: Factory install glazing in doors, complying with Section 08800 "Glazing." Install glass using manufacturer's standard elastomeric glazing sealant complying with ASTM C 920. Secure glass in place with removable wood moldings. Miter wood moldings at corner joints.

### 2.5 FINISHING

**A.** Finish wood doors at factory that are indicated to receive transparent finish.

**B.** For doors indicated to be factory finished, comply with the AWI's, AWMAC's, and WI's "Architectural Woodwork Standards," WDMA I.S.6A, "Industry Standard for Architectural Stile and Rail Doors," and with other requirements specified.

1. Finish faces and all four edges of doors, including mortises and cutouts. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.
C. Use only paints and coatings that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Transparent Finish:
   1. Grade: Premium.
   2. Finish: AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" System 9, UV curable, acrylated epoxy, polyester, or urethane.

PART 3 - EXECUTION

3.1 EXAMINATION

   A. Examine doors and installed door frames, with Installer present, before hanging doors.
   1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
   2. Reject doors with defects.

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

3.2 INSTALLATION

   A. Hardware: For installation, see Section 087100 "Door Hardware.

   B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.

   C. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted with fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.

      1. Clearances: Provide 1/8 inch (3 mm) at heads, jambs, and between pairs of doors. Provide 1/8 inch (3 mm) 1/4 inch (6 mm) 3/8 inch (10 mm) 1/2 inch (13 mm) from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch (6 mm) 3/8 inch (10 mm) from bottom of door to top of threshold unless otherwise indicated.
         a. Comply with NFPA 80 for fire-rated doors.
      2. Bevel non-fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock and hinge edges.
      3. Bevel fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) on lock edge; trim stiles and rails only to extent permitted by labeling agency.

   D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
E. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 082120
SECTION 083213

SLIDING ALUMINUM-FRAMED GLASS DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: This Section specifies aluminum-framed, thermally broken, impact resistant, slim profile lift and slide glass door systems.

B. Related Requirements:
   1. Section 076200 Sheet Metal Flashing and Trim.
   2. Section 079200 Joint Sealants.
   3. Section 087100 Door Hardware: Other than wheel carriages and handles.

1.3 REFERENCES

A. Reference Standards:

   1. American Architectural Manufacturers Association (AAMA)

   2. ASTM International (ASTM):
      b. ASTM E 1423 Standard Practice for Determining Steady State Thermal Transmittance of Fenestration System
1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate work of this Section with work of other trades for proper
time and sequence to avoid construction delays.

1.5 ACTION SUBMITTALS

A. General: Submit listed submittals in accordance with general provisions of the contract,
including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections.

B. Product Data: Submit specified products as follows:

1. Manufacturer’s product data, including manufacturer’s SPEC-DATA product sheet.
2. Catalog pages illustrating products to be incorporated into project.
3. Material Safety Data Sheets (MSDS).

C. Shop Drawings: Indicate information on shop drawings as follows:

1. Detailed plans, elevations and sections.
2. Hardware, accessories, operational clearances.
3. Details

D. Design Data: Submit engineering data illustrating compliance with specified
design and performance criteria. Have submittal signed and sealed by the Li-
censed Professional.

1.6 INFORMATION SUBMITTALS

A. General: Submit listed submittals in accordance with Contract Conditions.

B. Test and Evaluation Reports:

1. Certified test reports showing compliance with specified performance characteris-
tics and physical properties.

C. Manufacturer’s Instructions: Submit manufacturer’s storage and installation instructions.

D. Source Quality Control: Submit documentation verifying that components and materials
specified in this Section are from single manufacturer.

E. Qualification Statements:
1. Submit letter of verification for Manufacturer’s Qualifications.
2. Submit letter of verification for Licensed Professional’s Qualifications.

1.7 CLOSEOUT SUBMITTALS
A. General: Submit listed submittals in accordance with Contract Conditions
B. Submit operation and maintenance data for installed products, Include:
   1. Manufacturer’s instructions detailing maintenance requirements.
   2. Parts catalog giving showing complete list of available parts.
   3. Replacement parts with cuts and identifying numbers.
C. Warranty Documentation: Submit warranty documents specified.

1.8 QUALITY ASSURANCE
A. Qualifications:
   1. Manufacturer:
      a. 7 years of experience manufacturing components similar to or exceeding requirements of project in the US.
      b. Having sufficient capacity to produce and deliver required materials without causing delay in work.
   2. Licensed Professional: A Professional Structural Engineer experienced in fenestration design and licensed at the State in which the Project is located.

1.9 DELIVERY, STORAGE & HANDLING
A. Delivery and Acceptance Requirements:
   1. Deliver materials in manufacturer’s original packaging with identification labels intact and in sizes to suit project.
B. Storage and Handling Requirements:
   1. Store product flat in dry well ventilated area protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.
   2. During construction, keep the protective film to prevent your product from getting scratched or damaged by dirt and debris.
   3. Wood products should not be exposed to extreme changes in heat or humidity. Store materials protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.
1.10 WARRANTY

A. Warranty: Refer to Contract Conditions for project warranty provisions.

B. Manufacturer’s Warranty: Submit, for Owner’s acceptance, manufacturer’s standard warranty document executed by authorized company official. Manufacturer’s warranty is in addition to and does not limit, other rights Owner may have under other Contract Documents.

1. Warranty Term:
   a. Material: 10 years commencing on shipping date.
   b. Service: 2 years commencing shipping on date.

Specifier Note: Include statements specific to this Section that supplement or extend warranties contained in the Contract Conditions.

C. Special Warranty:

1. Warranty Term: 2yrs commencing on shipping date.

PART 2 - PRODUCTS

2.1 LIFT & SLIDE GLASS DOOR SYSTEMS

A. Manufacturer: Panda Windows and Doors.

1. Contact: 3415 Bellington Rd., N. Las Vegas, NV 89030; Phone: 702-643-5700, Fax: 702-643-5715; E-mail: panda@panda-windows.com; Website: www.panda-windows.com.


B. Description:

1. Compatibility:
   a. Ensure components and materials are compatible with specified accessories and adjacent materials.

C. Design Criteria:

2. Thermal Movement: Allow for thermal movement of materials based on 120 degrees F (49 degrees C)
3. Impact (Windborne-Debris) Resistance: Provide Lift & Slide aluminum-framed glass doors capable of resisting impact from windborne debris according to ASTM E1886 and when tested in accordance with ASTM E 1996 or AAMA 506 and requirements of authorities having jurisdiction.
D. Performance Criteria:
1. Condensation Resistance Factor (CRF) AAMA 1503/NFRC 500: Not less than 45.
2. Thermal Resistance (U-Factor) AAMA 1503/ASTM E 1423/NFRC 100: 0.65

E. Components:
1. Track: Standard: 2\(\frac{1}{2}\) (63.5 mm) inch deep recessed track with \(\frac{3}{16}\) inch (5 mm) rail exposure.
2. Weatherstripping: Provide EPDM, double “V” gasket to create a totally weather tight seal. At each panel interlock, provide 0.220 inch (5.588 mm) high polypile with center fin.

F. Materials:
2. Low-e-coated, Clear Insulating Glass Units.
   a) Overall Unit Thickness: 1 inch (25.4 mm).
   b) Thickness of Each Glass Lite: 15/64 inch (6.0 mm).
   c) Outdoor Lite: Fully tempered float glass.
   d) Interspace Content: Argon Gas.
   e) Indoor Lite: Fully tempered float glass.
   f) Low-E Coating: Solar Ban rx100 clear + clear
      2) Tinted.
      3) Single Glazed Tempered.
      4) Obscured.
      5) Laminated.
      6) Impact Glass.

G. Labeling: Permanently mark units with certification label of the SGCC. the SGCC or another certification agency acceptable to authorities having jurisdiction. Indicate manufacturer’s name, type of glass, thickness and safety glazing standard with which glass complies.

H. Fabrication:
1. General:
   a. Fabricate aluminum components before finishing.
   b. Fabricate sliding aluminum-framed glass doors for openings indicated.
2. Glazing: Glaze sliding aluminum-framed glass door panels in the factory.
3. Door Panels:
   a. Cladding is attached with polyamide clips to create thermal barrier.
   b. Aluminum extrusions manufactured from 6063-T5, thermally broken by an 18 mm polyamide bar.
SLIDING ALUMINUM-FRAMED GLASS DOORS

I. Finishes:
   1. Aluminum:
      a. Powder Coat: AAMA 2604: Dark Bronze

2.2 ACCESSORIES

   A. Fasteners: Manufacturer’s standard, stainless steel noncorrosive fasteners, compatible with sliding glass door members and other components.
      1. Exposed Fasteners: Avoid exposed fasteners to the greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

   B. Shims: Provide manufacturer recommended plastic precision shims.

PART 3-EXECUTION

3.1 EXAMINATION

   A. Verification of Conditions: Verify that conditions of substrates previously installed under other sections or contracts are acceptable for product installation in accordance with manufacturer’s instructions prior to Lift & Slide door system installation.
      1. Inform Owner and Architect of unacceptable conditions immediately upon discovery.
      2. Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval from Owner.

3.2 PREPARATION

   A. Ensure structure or substrate is adequate to support Lift & Slide glass door system.

3.3 INSTALLATION

   A. Coordinate Lift & Slide glass door system work with work of other trades for proper time and sequence to avoid construction delays.
   B. Install Lift & Slide glass door system plumb and level.
   C. Accurately fit, align, securely fasten and install free from distortion or defects.

3.4 ADJUSTING

   A. Adjust components and systems for correct function and operation in accordance with manufacturer’s written instructions.
   B. Lubricate moving parts to operate smoothly and fit accurately.

3.5 CLOSEOUT ACTIVITIES
SLIDING ALUMINUM-FRAMED GLASS DOORS

A. Training:

1. Instruct Owner’s designated maintenance personnel in care, adjustment and operation of Lift & Slide glass door system.

2. Provide competent instructor for not less than 1 four-hour training session(s) after completion and acceptance of work.

3.6 PROTECTION

A. Repair damage to adjacent materials caused by slide and lift door system installation.

B. Promptly seal and finish within one week of installation and prior to weather exposure.

END OF SECTION 083213
SECTION 083313

COILING COUNTER DOORS

PART 1  GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

Coiling Counter Doors, manually operated.

1.3 RELATED SECTIONS

Section 055013 - Metal Fabrications: Support framing and framed opening.

1.4 REFERENCES

ASTM A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

ASTM A 666 - Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.


1.5 SUBMITTALS

A. Submit under provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Product Data: Manufacturer’s data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Details of construction and fabrication.
   4. Installation methods.

C. Shop Drawings: Include detailed plans, elevations, and details of framing members, required clearances, anchors, and accessories. Include relationship with adjacent construction.

D. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer’s full range of available colors and patterns.
E. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in performing Work of this section with a minimum of five years’ experience in the fabrication and installation of security closures.

B. Installer Qualifications: Company specializing in performing Work of this section with minimum three years and approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Protect materials from exposure to moisture. Do not deliver until after wet work is complete and dry.

C. Store materials in a dry, warm, ventilated weathertight location.

1.8 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.9 COORDINATION

A. Coordinate Work with other operations and installation of adjacent finish materials to avoid damage to installed materials.

1.10 WARRANTY

A. Warranty: Manufacturer’s limited door warranty for 2 years for all parts and components.

B. Manufacturer’s 5 year limited warranty for Weathered Powder Coat Finish applied to complete door system.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. MANUFACTURER

1. Basis of Design: Overhead Door Corp, 651 Series

B. Acceptable Manufacturer:

1. Cookson
2. Cornell
3. Clopay Building Products
2.2 OVERHEAD COILING STEEL COUNTER DOORS
   A. Stainless Steel Counter Doors
      1. Wall Mounting Condition: Face-of-wall mounting
      2. Curtain: Interlocking slats, Type F-158 fabricated of 22 gauge stainless steel.
         Endlocks attached to alternate slats to maintain curtain alignment and prevent
         lateral slat movement
      3. Finish
         a. Slats and hood stainless steel with a No. 4 stainless steel finish.
         b. Non-galvanized exposed ferrous surfaces shall receive one coat of rust-
            inhibitive primer.
      5. Guides: Stainless steel shapes.
      6. Brackets: Steel plate to support counterbalance, curtain and hood.
      7. Counterbalance: Helical torsion spring type housed in a steel tube or pipe
         barrel.
      8. Hood: Provided with intermediate support brackets as required and fabricated
         of Stainless steel.
      10. Locking: Slide bolt locks suitable for use with padlock.

PART 3 EXECUTION

3.1 EXAMINATION
   A. Verify opening sizes, tolerances and conditions are acceptable.
   B. Examine conditions of substrates, supports, and other conditions under which
      this work is to be performed.
   C. If substrate preparation is the responsibility of another installer, notify Architect of
      unsatisfactory preparation before proceeding.

3.2 PREPARATION
   A. Clean surfaces thoroughly prior to installation.
   B. Prepare surfaces using the methods recommended by the manufacturer for
      achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION
   A. Install in accordance with manufacturer’s instructions.
   B. Use anchorage devices to securely fasten assembly to wall construction and
      building framing without distortion or stress.
   C. Securely and rigidly brace components suspended from structure. Secure guides
      to structural members only.
   D. Fit and align assembly including hardware; level and plumb, to provide smooth
      operation.
3.4 ADJUSTING

A. Test for proper operation and adjust as necessary to provide proper operation without binding or distortion.

B. Adjust hardware and operating assemblies for smooth and noiseless operation.

3.5 CLEANING

A. Clean curtain and components using non-abrasive materials and methods recommended by manufacturer.

B. Remove labels and visible markings.

C. Touch-up, repair or replace damaged products before Substantial Completion.

3.6 PROTECTION

A. Protect installed products until completion of project.

END OF SECTION 083313
SECTION 084110

ALUMINUM-FRAMED ENTRANCES AND CURTAINWALL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Exterior and interior aluminum-framed curtainwall.
   a. Glazing is retained mechanically with gaskets on four sides.
   b. Glazing on exterior is secured with aluminum cap system and structural silicone system.

2. Exterior manual-swing aluminum doors.

3. Exterior aluminum door frames.

B. Related Sections include the following:

1. Division 7 Section 079200 "Joint Sealants" for installation of joint sealants installed with aluminum-framed systems and for sealants to the extent not specified in this Section.

2. Division 8 Section 087100 "Door Hardware" for hardware to the extent not specified in this Section.

3. Division 8 Section 088000 "Glazing" for glazing requirements to the extent not specified in this Section.

4. Division 8 Section 083213 "Sliding aluminum-framed glass doors" for requirements to the extent not specified in this Section.

1.3 PERFORMANCE REQUIREMENTS

A. General: Provide aluminum-framed systems, including anchorage, capable of withstanding, without failure, the effects of the following:

1. Structural loads.

2. Thermal movements.

3. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
4. Dimensional tolerances of building frame and other adjacent construction.

5. Failure includes the following:
   a. Deflection exceeding specified limits.
   b. Thermal stresses transferred to building structure.
   c. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
   d. Glazing-to-glazing contact.
   e. Noise or vibration created by wind and thermal and structural movements.
   f. Loosening or weakening of fasteners, attachments, and other components.
   g. Sealant failure.
   h. Failure of operating units to function properly.

B. Structural-Sealant Joints: Designed to produce tensile or shear stress in structural-sealant joints of less than 20 psi (138 kPa).

C. Structural Loads:
   1. Wind Storm Speeds: 120 MPH, Sustained.
   2. Wind Storm Speeds: 150 MPH, Gusts.

D. Deflection of Framing Members:
   1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m) or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19 mm), whichever is less.
   2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller, and the amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components directly below to less than 1/8 inch (3.2 mm) and clearance between members and operable units directly below to less than 1/16 inch (1.5 mm).

E. Structural-Test Performance: Provide aluminum-framed systems tested according to ASTM E 330 as follows:
   1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
   2. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
   3. Test Durations: As required by design wind velocity but not less than 10 seconds.

F. Windborne-Debris-Impact-Resistance-Test Performance: Provide aluminum-framed systems that pass large and small missile-impact tests and cyclic-pressure tests according to testing requirements.
1. Design Displacement: Per Miami-Dade County requirements for Force 5 Hurricane wind borne debris.

2. Test Performance: Meeting criteria for passing based on building occupancy type when tested according to AAMA 501.4 at design displacement and 1.5 times design displacement.

G. Thermal Movements: Provide aluminum-framed systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

   a. Test High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F (82 deg C).

   b. Test Low Exterior Ambient-Air Temperature: 0 deg F (minus 18 deg C).

   c. Test Interior Ambient-Air Temperature: 75 deg F (24 deg C).

H. Air Infiltration: Provide aluminum-framed systems with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. (0.03 L/s per sq. m) of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 6.24 lbf/sq. ft. (300 Pa).

I. Water Penetration Under Static Pressure: Provide aluminum-framed systems that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).

J. Water Penetration Under Dynamic Pressure: Provide aluminum-framed systems that do not evidence water leakage through fixed glazing and framing areas when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).

K. Condensation Resistance: Provide aluminum-framed systems with fixed glazing and framing areas having condensation-resistance factor (CRF) of not less than 53 when tested according to AAMA 1503.

L. Average Thermal Conductance: Provide aluminum-framed systems with fixed glazing and framing areas having average U-factor of not more than 0.69 Btu/sq. ft. x h x deg F (3.92 W/sq. m x K) when tested according to AAMA 1503.

M. Sound Transmission: Provide aluminum-framed systems with fixed glazing and framing areas having minimum STC 32 according to ASTM E 413 and an OITC 26 according to ASTM E 1332, as determined by testing according to ASTM E 90.
1.4 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of product indicated.

B. Shop Drawings: For aluminum-framed systems. Include plans, elevations, sections, details, and attachments to other work.

1. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Include details of provisions for system expansion and contraction and for draining moisture occurring within the system to the exterior.
3. For entrances, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

E. Fabrication Sample: Of each vertical-to-horizontal intersection of systems, made from 12-inch (300-mm) lengths of full-size components and showing details of the following:

1. Joinery.
2. Anchorage.
5. Flashing and drainage.

F. Welding certificates.

G. Qualification Data: For Installer and testing agency.

H. Field quality-control test and inspection reports.

I. Maintenance Data: For aluminum-framed systems to include in maintenance manuals.

J. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Capable of assuming engineering responsibility and performing work of this Section and who is acceptable to manufacturer.

1. Engineering Responsibility: Preparation of data for aluminum-framed systems including Shop Drawings based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project and submission of reports of tests performed on manufacturer's standard assemblies.
B. Testing Agency Qualifications: An independent agency qualified according to ASTM E 699 for testing indicated.

C. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

D. Accessible Entrances: Comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), and the 2012 Texas Accessibility Standards (TAS).

E. Welding: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code-Aluminum."

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating aluminum-framed systems without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.7 WARRANTY

A. Special Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period.

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

   a. Structural failures including, but not limited to, excessive deflection.
   b. Noise or vibration caused by thermal movements.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   d. Adhesive or cohesive sealant failures.
   e. Water leakage through fixed glazing and framing areas.
   f. Failure of operating components to function properly.
2. Warranty Period: Two years from date of Substantial Completion.

B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, preference should be given to manufacturers offering products with sustainable components contributing to LEED certification, provide products by one of the following:

1. EFCO Corporation.
2. Kawneer.
3. United States Aluminum.
4. YKK AP America Inc.

2.2 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
4. Structural Profiles: ASTM B 308/B 308M.
5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

B. Steel Reinforcement: With manufacturer's standard corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.

1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.
2.3 FRAMING SYSTEMS

A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Construction: High-performance plastic connectors separate framing members exposed to the exterior from members exposed to the interior.

B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with non-staining, nonferrous shims for aligning system components.

C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.

1. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.

2. Reinforce members as required to receive fastener threads.

3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system only at unusual conditions.

D. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.

E. Flashing: Manufacturer's standard corrosion-resistant, non-staining, non-bleeding flashing compatible with adjacent materials. Form exposed flashing from sheet aluminum finished to match framing and of sufficient thickness to maintain a flat appearance without visible deflection.

F. Framing System Gaskets and Sealants: Manufacturer's standard recommended by manufacturer for joint type.

2.4 GLAZING SYSTEMS

A. Glazing: As specified in Division 8 Section 088000 "Glazing."

B. Glazing Gaskets: Manufacturer's standard compression types, replaceable, molded or extruded, that maintain uniform pressure and watertight seal.

C. Spacers and Setting Blocks: Manufacturer's standard elastomeric types.

D. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.

E. Structural Silicone: Manufacturer’s standard exterior structural silicone vertically applied system as indicated on the drawings.
2.5 DOORS

A. Doors: Manufacturer's standard glazed doors, for manual swing operation.

1. Door Construction: 1-3/4-inch (44.5-mm) overall thickness, with minimum 0.125-inch-(3.2-mm) thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deep penetration and fillet welded or that incorporate concealed tie rods.

   a. Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior >.

2. Door Design: As indicated on the drawings.

   a. Accessible Doors: Smooth surfaced for width of door in area within 10 inches (255 mm) above floor or ground plane.


   a. Provide non-removable glazing stops on inside of door.

2.6 DOOR HARDWARE

A. General: Provide heavy-duty units in sizes and types recommended by entrance system and hardware manufacturers for entrances and uses indicated.

1. Opening-Force Requirements:

   a. Egress Doors: Not more than 30 lbf (133 N) required to set door in motion and not more than 15 lbf (67 N) required to open door to minimum required width.

   b. Accessible Interior Doors: Not more than 5 lbf (22.2 N).

B. Scheduled Door Hardware: Provide door hardware according to the Door Hardware Schedule at the end of Part 3.

1. Named Manufacturer's Products: Product designation and hardware manufacturer are listed in the Door Hardware Schedule at the end of Part 3 to establish minimum requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware.

   a. Provide named hardware manufacturer's products.

   b. Named products are basis-of-design products. Provide named hardware manufacturer's products or comparable products that are equivalent in function and quality and that are recommended and supplied by entrance system manufacturer.
2. References to BHMA Standards: Provide products complying with standards referenced in this Article and with requirements for description, quality, type, and function listed in the Door Hardware Schedule in 087100 “Door Hardware”.

C. Continuous-Gear Hinges: Exterior Single or Double Leaf Doors. Manufacturer's standard with stainless-steel bearings between knuckles; fabricated to full height of door and frame.

D. Locking Devices, General: Do not require use of key, tool, or special knowledge for operation.

1. Opening-Force Requirements:

   a. Latches and Exit Devices: Not more than 15 lbf (67 N) required to release latch.

E. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.

   1. Low profile, mid-rail touch bar with concealed rods to head sill, for each door leaf.

F. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.

G. Operating Trim: As selected by contractor.

H. Closers: With accessories required for a complete installation, sized as required by door size, exposure to weather, and anticipated frequency of use, and adjustable to meet field conditions and requirements for opening force.


I. Door Stops: BHMA A156.16, Grade 1, floor or wall mounted, as appropriate for door location indicated, with integral rubber bumper.

J. Weather Stripping: Manufacturer's standard replaceable components.

   1. Compression Type: Made of ASTM D 2000, molded neoprene, or ASTM D 2287, molded PVC.

   2. Sliding Type: AAMA 701, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

K. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.

L. Silencers: BHMA A156.16, Grade 1.

M. Thresholds: Raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch (13 mm).

2.7 ACCESSORY MATERIALS

A. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Division 7 Section 079200 "Joint Sealants."

B. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

2.8 FABRICATION

A. Form aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Means to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
4. Physical and thermal isolation of glazing from framing members.
5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing (without projecting stops).

E. Curtainwall Framing: Fabricate components for assembly using shear-block system, or screw-spline system, or head-and-sill-receptor system with shear blocks at intermediate horizontal members.

F. Door Frames: Reinforce as required to support loads imposed by door operation and for installing hardware.

1. At exterior doors, provide compression weather stripping at fixed stops.
2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.

G. Doors: Reinforce doors as required for installing hardware.
1. At pairs of exterior doors, provide sliding weather stripping retained in adjustable strip mortised into door edge.
2. At exterior doors, provide weather sweeps applied to door bottoms.

H. Hardware Installation: Factory install hardware to the greatest extent possible. Cut, drill, and tap for factory-installed hardware before applying finishes.

I. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.9 ALUMINUM FINISHES

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

C. High-Performance Organic Finish (3-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard 3-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2604 and with coating and resin manufacturers’ written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

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

3.2 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
6. Seal joints watertight, unless otherwise indicated.
B. Metal Protection:

1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.

2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

D. Set continuous sill members and flashing in full sealant bed as specified in Division 7 Section 079200 "Joint Sealants" and to produce weathertight installation.

E. Install components plumb and true in alignment with established lines and grades, without warp or rack.

F. Install glazing as specified in Division 8 Section 088000 "Glazing."

   1. Structural-Sealant Glazing:
      
      a. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

      b. Install weatherseal sealant according to Division 7 Section 079200 "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

G. Entrances: Install to produce smooth operation and tight fit at contact points.

   1. Exterior Entrances: Install to produce tight fit at weather stripping and weathertight closure.

   2. Field-Installed Hardware: Install surface-mounted hardware according to hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

H. Install insulation materials as specified in Division 7 Section 072100 "Thermal Insulation."

I. Install perimeter joint sealants as specified in Division 7 Section 079200 "Joint Sealants" and to produce weathertight installation.

J. Erection Tolerances: Install aluminum-framed systems to comply with the following maximum tolerances:

   1. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3 mm in 3.7 m); 1/4 inch (6 mm) over total length.

   2. Alignment:
      
      a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch (1.5 mm).
b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch (0.8 mm).

3. Diagonal Measurements: Limit difference between diagonal measurement to 1/8 inch (3 mm).

3.3 ADJUSTING

A. Entrances: Adjust operating hardware for smooth operation according to hardware manufacturers’ written instructions.

1. For doors accessible to people with disabilities, adjust closers to provide a 3-second closer sweep period for doors to move from a 70-degree open position to 3 inches (75 mm) from the latch measured to the leading door edge.
1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and TPWD's Uniform General Conditions.

1.2 SUMMARY

A. Section Includes:
   1. Door hardware.
   2. Storefront and entrance door hardware
   3. Cylinders for doors fabricated with locking hardware

B. Related Divisions:
   1. Division 06 – wood, plastics, and composites
   2. Division 07 – sealant at exterior thresholds
   3. Division 08 – metal doors and frames, interior aluminum frames, wood doors, integrated security systems, specialty doors, storefront and glazed curtainwall systems
   4. Division 10 - operable partitions
   5. Division 28 – security access systems

1.3 REFERENCES

A. Section Includes:
   1. ADAAG – Americans with Disabilities Act Accessibility Guidelines of 2010
   2. ANSI A117.1 - Specifications for Making Building and Facilities Accessible to and Usable by physically Handicapped People.
   3. BHMA – Builders Hardware Manufacturers Association
   4. DHI – Door Hardware Institute
   5. NFPA 80 – Fire Doors and Windows
   6. AWI – Architectural Woodwork Institute – Quality Standards
   7. NFPA 101 – Code for Safety to Life from Fire and Buildings and Structures
   8. NFPA 252 – Fire Tests of Door Assemblies
   9. TAS – Texas Accessibility Standards
   10. UL 10B – Fire Tests of Door Assemblies
   11. UL 305 – Panic Hardware
   12. WHI – Warnock Hersey Incorporated
   13. Local applicable codes
   14. SDI – Steel Door Institute
   15. NAAMM – National Association of Architectural Metal Manufacturers

1.4 SUBMITTALS & SUBSTITUTIONS

A. Substitution request shall be submitted per TPWD's Uniform General Conditions

B. SUBMITTALS: Submit six copies of schedule per TPWD's Uniform General Conditions to include the following information:
   1. Type, style, function, size, quantity and finish of hardware items
   2. Use BHMA Finish codes per ANSI A156.18.
3. Name, part number and manufacturer of each item.
4. Fastenings and other pertinent information.
5. Location of hardware set coordinated with floor plans and door schedule.
6. Explanation of abbreviations, symbols, and codes contained in schedule.
7. Mounting locations for hardware.
8. Door and frame sizes, materials and degrees of swing.
9. List of manufacturers used and their nearest representative with address and phone number.
10. Catalog cuts.
11. Point-to-point wiring diagrams.
12. Manufacturer’s technical data and installation instructions for electronic hardware.

C. Bid and submit manufacturer’s updated/improved item if scheduled item is discontinued.
D. Deviations: Highlight, encircle or otherwise identify deviations from “Schedule of Finish Hardware” on submittal with notations clearly designating those portions as deviating from this section.
E. If discrepancy between drawings and scheduled material in this section, bid the more expensive of the two choices, note the discrepancy in the submittal and request direction from Architect for resolution.
F. Substitutions per TPWD’s Uniform General Conditions.
G. Items listed with no substitute manufacturers have been requested by Owner to meet existing standard
H. Furnish as-built/as-installed schedule with closeout documents, including keying schedule, riser and point-to-point wiring diagrams, manufacturers’ installation, adjustment and maintenance information, and supplier’s final inspection report.

1.5 QUALITY ASSURANCE

A. Qualifications:
   1. Hardware supplier: Supplier Company specializing in supplying commercial door hardware with five years documented experience who employs a certified architectural hardware consultant (AHC), available at reasonable times during course of work for project hardware consultation to Owner, Architect and Contractor.
      a) Responsible for detailing, scheduling and ordering of finish hardware. Detailing implies that the submitted schedule of hardware is correct and complete for the intended function and performance of the openings.
   B. Exit Doors: Operable from inside with single motion without the use of a key or special knowledge or effort.
   C. Fire-Rated Openings: NFPA 80 compliant. Hardware UL10C Standard 7-2 (positive pressure) compliant for given type/size opening and degree of label. Provide proper latching hardware, non-flaming door closers, approved-bearing hinges, and resilient seals. Coordinate with wood door section for required intumescent seals. Furnish openings complete.
   D. Furnish hardware items required to complete the work in accordance with specified performance level and design intent, complying with manufacturers’ instructions and code requirements.
   E. Pre-Installation Meetings: Initiate and conduct with supplier, installer and related trades, coordinate materials and techniques, and sequence complex hardware items and systems installation. Include manufacturers’ representatives of locks, panic hardware and door closers in the meetings. Convene prior to commencement of related work.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery: coordinate delivery to appropriate locations (shop or field).
1. Permanent keys and cores: secured delivery direct to Owner’s representative.

B. Acceptance at Site: Items individually packaged in manufacturers’ original containers, complete with proper fasteners and related pieces. Clearly mark packages to indicate contents, locations in hardware schedule and door numbers.

C. Storage: Deliver, store, protect and handle products to site under provisions of TPWD’s Uniform General Conditions.

1.7 PROJECT CONDITIONS AND COORDINATION

A. Where exact types of hardware specified are not adaptable to finished shape or size of members requiring hardware, provide suitable types having as nearly as practical the same operation and quality as type specified, subject to Architect’s approval.

B. Coordination: Coordinate hardware with other work. Furnish hardware items of proper design for use on doors and frames of the thickness, profile, swing, security and similar requirements indicated, as necessary for proper installation and function, regardless of omissions or conflicts in the information on the Contract Documents. Furnish related trades with the following information:

1. Location of embedded and attached items to concrete.
2. Location of wall-mounted hardware, including wall stops.
3. Location of finish floor materials and floor-mounted hardware.
4. At masonry construction, coordinate with the anchoring and hollow metal supplier prior to frame installation by placing a strip of insulation, wood, or foam, on the back of the hollow metal frame behind the rabbet section for continuous hinges, as well as at rim panic hardware strike locations, silencers, coordinators, and door closer arm locations. When the frame is grouted in place, the backing will allow drilling and tapping without dulling or breaking the installer’s bits.
5. Locations for conduit and raceways as needed for electrical, electronic and electro-pneumatic hardware items. Fire/life-safety system interfacing. Point-to-point wiring diagrams plus riser diagrams to related trades.
6. Coordinate: flush top rails of doors at outswinging exteriors, and throughout where adhesive-mounted seals occur.
7. Manufacturers’ templates to door and frame fabricators.

C. Check Shop Drawings for doors and entrances to confirm that adequate provisions will be made for proper hardware installation.

D. Environmental considerations: segregate unused recyclable paper and paper product packaging, uninstalled metals, and plastics, and have these sent to a recycling center.

1.8 WARRANTY

A. Part of respective manufacturers’ regular terms of sale. Provide manufacturers’ written warranties:

1. Extra Heavy Duty Cylindrical Lock: Ten years
2. Exit Devices: Three years mechanical
   One year electrical
3. Closers: Ten years mechanical
4. Hinges: Ten years

PART 2 – PRODUCTS

2.1 MANUFACTURERS AND MATERIALS

A. Manufacturers and their abbreviations used in this schedule:
### 2.2 HINGING METHODS

A. Note: drawings typically depict doors at 90 degrees doors will actually swing to maximum allowable. Use wide-throw conventional or continuous hinges as needed up to 8 inches in width to allow door to stand parallel to wall for true 180-degree opening. Advise architect if 8-inch width is insufficient.

B. Conventional Hinges: Steel or stainless steel pins and concealed bearings. Hinge open widths minimum, but of sufficient throw to permit maximum door swing.

   1. Three hinges per leaf to 7 foot, 6 inch height. Add one for each additional 30 inches in height, or any fraction thereof.
   2. Extra heavy weight hinges on doors over 3 feet, 5 inches in width.
   3. Extra-heavy weight hinges on doors with panic hardware or fire exit devices.
   5. Non-ferrous material exteriors and at doors subject to corrosive atmospheric conditions.
   6. Provide shims and shimming instructions for proper door adjustment.
   7. All hinges to be ball bearing type. Plain Bearing hinges are not acceptable for any project.

### 2.3 MORTISE LOCKS

A. Manufacturers and Products:


B. Requirements:

   1. Provide mortise locks conforming to ANSI/BHMA A156.13 Series 1000, Grade 1, and UL Listed for 3 hour fire doors.
   2. Provide locks manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance.
   3. Provide lock case that is multi-function and field reversible for handing without opening case. Cylinders: Refer to "KEYING" article, herein.
   4. Provide locks with standard 2-3/4 inches (70 mm) backset with full 3/4 inch (19 mm) throw stainless steel mechanical anti-friction latchbolt. Provide deadbolt with full 1 inch (25 mm) throw, constructed of stainless steel.
   5. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
   6. Provide electrified options as scheduled in the hardware sets. Where scheduled, provide switches and sensors integrated into the locks and latches.
   7. Lever Trim: Solid brass, bronze, or stainless steel, cast or forged in design specified, with wrought roses and external lever spring cages. Provide thru-bolted levers with 2-piece spindles.

   a. Lever Design: Schlage 17A
2.4 EXIT DEVICES/PANIC HARDWARE

A. Scheduled Manufacturer and Product:

1. Scheduled Manufacturer and Product: Von Duprin 99/33 Series

B. Requirements:

1. Provide exit devices tested to ANSI/BHMA A156.3 Grade 1 and UL listed for Panic Exit or Fire Exit Hardware.
2. Cylinders: Refer to "KEYING" article, herein.
3. Provide touchpad type exit devices, fabricated of brass, bronze, stainless steel, or aluminum, plated to standard architectural finishes to match balance of door hardware.
4. Touchpad must extend a minimum of one half of door width. No plastic inserts are allowed in touchpads.
5. Provide exit devices with deadlatching feature for security and for future addition of alarm kits and/or other electrified requirements.
6. Provide flush end caps for exit devices.
7. Provide exit devices with manufacturer's approved strikes.
8. Provide exit devices cut to door width and height. Install exit devices at height recommended by exit device manufacturer, allowable by governing building codes, and approved by Architect.
9. Mount mechanism case flush on face of doors, or provide spacers to fill gaps behind devices. Where glass trim or molding projects off face of door, provide glass bead kits.
10. Provide cylinder or hex-key dogging as specified at non fire-rated openings.
11. Removable Mullions: 2 inches (51 mm) x 3 inches (76 mm) steel tube. Where scheduled as keyed removable mullion, provide type that can be removed by use of a keyed cylinder, which is self-locking when re-installed.
12. Provide factory drilled weep holes for exit devices used in full exterior application, highly corrosive areas, and where noted in hardware sets.
13. Provide electrified options as scheduled.
14. Top latch mounting: double or single tab mount for steel doors, face mount for aluminum doors eliminating requirement of tabs, and double tab mount for wood doors.
15. Provide exit devices with optional trim designs to match other lever and pull designs used on the project.

2.5 Closers

A. Manufacturers and Products:


B. Requirements:

1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.
2. Provide door closers with fully hydraulic, full rack and pinion action with high strength cast iron cylinder, and full complement bearings at shaft.
3. Cylinder Body: 1-1/2 inch (38 mm) diameter with 3/4 inch (19 mm) diameter double heat-treated pinion journal.

4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.

5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.

6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck.

7. Provide closers with solid forged steel main arms and factory assembled heavy-duty forged forearms for parallel arm closers.

8. Pressure Relief Valve (PRV) Technology: Not permitted.

9. Finish for Closer Cylinders, Arms, Adapter Plates, and Metal Covers: Powder coating finish which has been certified to exceed 100 hours salt spray testing as described in ANSI Standard A156.4 and ASTM B117, or has special rust inhibitor (SRI).

10. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.6 OTHER HARDWARE

A. Automatic Flush Bolts: Low operating force design, “LBR” type where scheduled.

B. Surface Bolts: Shall be used at pairs of doors from non-fire rated Mechanical rooms for the inactive leaf.

C. Overhead Stops: Stainless steel (100 series). Non-plastic mechanisms and finished metal end caps. Field-changeable hold-open, friction and stop-only functions.

D. Kick Plates: Four beveled edges, 0.050 inches minimum thickness, height and width as scheduled. Sheet-metal screws of bronze or stainless steel to match other hardware.

E. Door Stops: Provide stops to protect walls, casework or other hardware.
   1. Unless otherwise noted in Hardware Sets, provide wall type Ives WS402 with appropriate fasteners. Where wall type cannot be used, provide floor type. (Ives FS18S exterior and FS436 Interior) If neither can be used, provide overhead type.

F. Seals: Finished to match adjacent frame color. Resilient seal material: polypropylene, nylon brush, or solid high-grade neoprene. UL label applied to seals on rated doors. Substitute products: certify that the products equal or exceed specified material's thickness and durability. Proposed substitutions: submit for approval.
   2. Non-corroding fasteners at in-swinging exterior doors.
   3. Exterior pairs of mechanical room doors: Doors shall be equipped with appropriate seals, astragal, threshold, drip cap and sweeps to prevent the intrusion of rain water. Provide astragals at all interior pairs of doors to mechanical rooms.
   4. Sound control openings: Use components tested as a system using nationally accepted standards by independent laboratories. Ensure that the door leafs have the necessary sealed-in-place STC ratings. Adhesive mounted components not acceptable. Fasten applied seals over bead of sealant.
   5. Fire-rated Doors, Resilient Seals: UL10C / UBC Standard 7-2 compliant. Coordinate with selected door manufacturers’ and selected frame manufacturers’ requirements. Where rigid housed resilient seals are scheduled in this section and the selected door manufacturer only requires an adhesive-mounted resilient seal, furnish rigid housed seal at minimum, or both the rigid housed seal plus the adhesive applied seal. Adhesive applied seals alone are deemed insufficient for this project where rigid housed seals are scheduled.
6. Fire-rated Doors, Intumescent Seals: Furnished by selected door manufacturer. Furnish fire-labeled opening assembly complete and in full compliance with UL10C / UBC Standard 7-2. Where required, Intumescent seals vary in requirement by door type and door manufacture -- careful coordination required. Adhesive-applied Intumescent strips are not acceptable, use concealed-in-door-edge type or kerfed-in-frame type.

G. Automatic door bottoms: low operating force units. Doors with automatic door bottoms plus head and jamb seals cannot require more than two pounds operating force to open when closer is disconnected.

H. Thresholds: As scheduled and per details. Substitute products: certify that the products equal or exceed specified material’s thickness. Proposed substitutions: submit for approval.

1. Exteriors: Seal perimeter to exclude water and vermin. Use butyl-rubber or polyisobutylene sealant complying with requirements in Division 7 “Thermal Insulation”. Non-ferrous 1/4inch fasteners and lead expansion shield anchors, or Red-Head #SFS-1420 (or approved equivalent) Flat Head Sleeve Anchors (SS/FHSL).

2. Acoustic openings: Set units in full bed of Division-7-compliant butyl-rubber or polyisobutylene sealant; leave no air space between threshold and substrate.

3. Plastic plugs with wood or sheet metal screws are not an acceptable substitute for specified fastening methods.

I. Fasteners: Generally, exposed screws to be Phillips or Robertson drive. Pinned TORX drive at high security areas. Flat head sleeve anchors (FHSL) may be slotted drive. Sheet metal and wood screws: full-thread. Sleeve nuts: full length to prevent door compression.

J. Silencers: Interior hollow metal frames, 3 for single doors, 4 for pairs of doors. Omit where adhesive mounted seal occurs. Leave no unfilled/uncovered pre-punched silencer holes.

K. Wall- & Floor-mounted electromagnetic door holders: LCN's SEM series or approved equivalent. Incorporate into U.L.-listed fire & life-safety system, doors release to allow closure and latching when door's zone is in alarm state. Use minimum projection required to allow door to open as widely as allowed by wall conditions and projection of door hardware.

2.7 FINISH:

A. Finish: BHMA 626/652 (US26D); except:

1. Hinges at Exterior Doors: BHMA 630 (US32D)
2. Continuous Hinges: BHMA 630 (US32D)
3. Continuous Hinges: BHMA 628 (US28)
5. Protection Plates: BHMA 630 (US32D)
6. Overhead Stops and Holders: BHMA 630 (US32D)
7. Door Closers: Powder Coat to Match
8. Wall Stops: BHMA 630 (US32D)
9. Latch Protectors: BHMA 630 (US32D)
10. Weatherstripping: Clear Anodized Aluminum
11. Thresholds: Mill Finish Aluminum

B. Finish: BHMA 613/640 (US10B); except:

2. Continuous Hinges: BHMA 710 (US10B)
5. Weatherstripping: Dark Bronze Anodized Aluminum.
6. Thresholds: Extruded Architectural Bronze, Oil-Rubbed
2.8 KEYING REQUIREMENTS

A. Keying Conference

1. Incorporate keying conference decisions into final keying scheduled after reviewing door hardware keying system including:
   a. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
   b. Preliminary key system schematic diagram.
   c. Requirements for key control system.
   d. Requirements for access control.
   e. Address for delivery of keys.

2. Pre-installation Conference
   a. Review and finalize construction schedule and verify availability of materials, installer’s personnel, equipment, and facilities needed to make progress and avoid delays.
   b. Inspect and discuss preparatory work performed by other trades.
   c. Inspect and discuss electrical roughing-in for electrified door hardware.
   d. Review sequence of operation for each type of electrified door hardware.
   e. Review required testing, inspecting, and certifying procedures.

3. Coordination Conferences
   a. Installation Coordination Conference: Prior to hardware installation, schedule and hold meeting to review questions or concerns related to proper installation and adjustment of door hardware.
   b. Electrified Hardware Coordination Conference: Prior to ordering electrified hardware, schedule and hold meeting to coordinate door hardware with security, electrical, doors and frames, and other related suppliers.

2.9 KEYING

A. Provide a factory registered keying system, complying with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.

B. Provide cylinders/cores keyed into Owner’s existing factory registered keying system.

C. Comply with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.

D. Provide cylinders/cores keyed into Owner’s existing keying system managed by Owner’s locksmith, complying with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference. Contact:
   a. Firm Name:
   b. Contact Person:
   c. Telephone:

E. Requirements:
   1. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.
      a. Master Keying system as directed by the Owner.
   2. Forward bitting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.
   3. Provide keys with the following features:
      a. Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
   4. Identification:
a. Mark permanent cylinders/cores and keys with applicable blind code per DHI publication “Keying Systems and Nomenclature” for identification. Do not provide blind code marks with actual key cuts.

b. Identification stamping provisions must be approved by the Architect and Owner.

c. Stamp cylinders/cores and keys with Owner’s unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with “DO NOT DUPLICATE” along with the “PATENTED” or patent number to enforce the patent protection.

d. Failure to comply with stamping requirements will be cause for replacement of keys involved at no additional cost to Owner.

e. Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.

5. Quantity: Furnish in the following quantities.
   a. Change (Day) Keys: 3 per cylinder/core.
   b. Permanent Control Keys: 3.

2.10 KEY CONTROL SYSTEM

A. Manufacturers:
   1. Scheduled Manufacturer: Telkee.

B. Requirements:
   1. Provide key control system, including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150% of number of locks required for Project.
      a. Provide complete cross index system set up by hardware supplier, and place keys on markers and hooks in cabinet as determined by final key schedule.
      b. Provide hinged-panel type cabinet for wall mounting.

PART 3 – EXECUTION

3.1 ACCEPTABLE INSTALLERS

A. Can read and understand manufacturers’ templates, suppliers’ hardware schedule and printed installation instructions. Can readily distinguish drywall screws from manufacturers’ furnished fasteners. Available to meet with manufacturers’ representatives and related trades to discuss installation of hardware.

3.2 PREPARATION

A. Ensure that walls and frames are square and plumb before hardware installation. Make corrections before commencing hardware installation. Installation denotes acceptance of wall/frame condition.

B. Locate hardware per SDI-100 and applicable building, fire, life-safety, accessibility, and security codes.
1. Notify Architect of code conflicts before ordering material.
2. Locate latching hardware between 34 inches to 44 inches above the finished floor, per California Building Code, Section 1008.1.9.2 and 1133B.2.5.2.
3. Locate panic hardware between 36 inches to 44 inches above the finished floor.
4. Where new hardware is to be installed near existing doors/hardware scheduled to remain, match locations of existing hardware.

C. Overhead stops: before installing, determine proposed locations of furniture items, fixtures, and other items to be protected by the overhead stop's action.

3.3 INSTALLATION

A. Install hardware per manufacturer's instructions and recommendations. Do not install surface-mounted items until finishes have been completed on substrate. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate for proper installation and operation. Remove and reinstall or replace work deemed defective by Architect.
1. Gaskets: install jamb-applied gaskets before closers, overhead stops, rim strikes, etc; fasten hardware over and through these seals. Install sweeps across bottoms of doors before astragals, cope sweeps around bottom pivots, trim astragals to tops of sweeps.
2. When hardware is to be attached to existing metal surface and insufficient reinforcement exists, use RivNuts, NutSerts or similar anchoring device for screws.
3. Use manufacturers' fasteners furnished with hardware items, or submit Request for Substitution with Architect.
4. Replace fasteners damaged by power-driven tools.

B. Locate floor stops no more than 4 inches from walls and not within paths of travel. See paragraph 2.2 regarding hinge widths, door should be well clear of point of wall reveal. Point of door contact no closer to the hinge edge than half the door width. Where situation is questionable or difficult, contact Architect for direction.

C. Core concrete for exterior door stop anchors. Set anchors in approved non-shrink grout.

D. Locate overhead stops for minimum 90 degrees at rest and for maximum allowable degree of swing.

E. Install closers inside building, stairs, and rooms as scheduled.

F. Use sex bolts to attach panic devices to wood doors and all closers.

G. Provide manufacturer's recommended brackets to accommodate the mounting of closers on doors with flush transoms.

3.4 ADJUSTING

A. Adjust and check for proper operation and function. Replace units, which cannot be adjusted to operate freely and smoothly.
1. Hardware damaged by improper installation or adjustment methods: repair or replace to Owner's satisfaction.
2. Adjust doors to fully latch with no more than 1 pound of pressure.
3. Adjust delayed-action closers on fire-rated doors to fully close from fully-opened position in no more than 10 seconds.
4. Adjust door closers per 1.9 this section.

B. Fire-rated doors:
1. Wood doors: adjust to 0.125 inches clearance at heads, jambs, and meeting stiles.
2. Steel doors: adjust to 0.063 inches minimum to 0.188 inches maximum clearance at heads, jambs, and meeting stiles.
3. Adjust wood and steel doors to 0.75 inches maximum clearance (undercut) above threshold or finish floor material under door.

C. Adjust closers to meet ADA
D. Final inspection: Installer to provide letter to Owner that upon completion installer has visited the Project and has accomplished the following:
1. Has re-adjusted hardware.
2. Has evaluated maintenance procedures and recommend changes or additions, and instructed Owner’s personnel.
3. Has identified items that have deteriorated or failed.

3.5 DEMONSTRATION

A. Demonstrate mechanical hardware and electrical, electronic and pneumatic hardware systems, including adjustment and maintenance procedures.

3.6 PROTECTION/CLEANING

A. Cover installed hardware, protect from paint, cleaning agents, weathering, carts/barrows, etc. Remove covering materials and clean hardware just prior to substantial completion.
B. Clean adjacent wall, frame and door surfaces soiled from installation / reinstallation process.

3.7 SCHEDULE OF FINISH HARDWARE

HARDWARE GROUP NO. 01

FOR USE ON MARK/DOOR #:(S):
V

PROVIDE EACH SL DOOR(S) WITH THE FOLLOWING:

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ALL HARDWARE BY COILING COUNTER DOOR MANUFACTURER. COORDINATE AND VERIFY KEYING REQUIREMENTS WITH MANUFACTURER PRIOR TO PURCHASING.

HARDWARE GROUP NO. 02

FOR USE ON MARK/DOOR #:(S):
W   Y

PROVIDE EACH SL DOOR(S) WITH THE FOLLOWING:

ALL BARN DOOR HARDWARE BY RUSTICA HARDWARE OR APPROVED EQUAL.
**DOOR HARDWARE**

**HARDWARE GROUP NO. 03**

FOR USE ON MARK/DOOR #(S):

J

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**HARDWARE GROUP NO. 04**

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**HARDWARE GROUP NO. 05**

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HARDWARE GROUP NO. 06

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-HARDWARE SET IS A GUIDELINE BASED ON SPECIAL LITE FRP DOORS/FRAMES, PROVIDE HARDWARE REQUIRED BASED ON FRP DOOR/FRAME BEING PROVIDED. OTHER MANUFACTURERS ARE CHEMPRUF, CORRIM, TIGER.

HARDWARE GROUP NO. 07

FOR USE ON MARK/DOOR #(S):
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### HARDWARE GROUP NO. 08

FOR USE ON MARK/DOOR #(S):

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### HARDWARE GROUP NO. 10

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HARDWARE GROUP NO. 11

FOR USE ON MARK/DOOR #S:
E  F

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

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HARDWARE GROUP NO. 12

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HARDWARE GROUP NO. 13

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-HARDWARE SET IS A GUIDELINE BASED ON SPECIAL LITE FRP DOORS/FRAMES, PROVIDE HARDWARE REQUIRED BASED ON FRP DOOR/FRAME BEING PROVIDED. OTHER MANUFACTURERS ARE CHEMPRUF, CORRIM, TIGER.

-CLASSROOM LOCK TO BE UNLOCKED DURING BUSINESS HOURS AND LOCKED AFTER BUSINESS HOURS.
HARDWARE GROUP NO. 14

FOR USE ON MARK/DOOR #(S):
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1 SET SEAL PERIMETER SEAL BY FRAME MANUFACTURER

1 SET ASTRAGAL MEETING STILE SEAL BY DOOR MANUFACTURER

2 EA DOOR SWEEP 39A LENGTH AS REQ

1 EA THRESHOLD 655A LENGTH AS REQ

HARDWARE GROUP NO. 15

FOR USE ON MARK/DOOR #(S):
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1 SET SEAL PERIMETER SEAL BY FRAME MANUFACTURER

1 EA DOOR SWEEP 39A LENGTH AS REQ

1 EA THRESHOLD 655A LENGTH AS REQ
HARDWARE GROUP NO. 16

FOR USE ON MARK/DOOR #S:
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END OF SECTION 087100

HARDWARE GROUP NO. 17

FOR USE ON MARK/DOOR #S:
CA  CB

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<td>23-030</td>
<td>626</td>
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HARDWARE SET IS A GUIDELINE. VERIFY & COORDINATE ALL HARDWARE WITH GATE MANUFACTURER PRIOR TO PURCHASING.
SECTION 088000

GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:

1. Windows.
2. Doors.
3. Glazed entrances.
4. Glazing sealants and accessories.

1.3 DEFINITIONS

A. Manufacturers of Glass Products: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.

D. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.

E. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
1.4 PERFORMANCE REQUIREMENTS

A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:

1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:

   a. Specified Design Wind Loads: As indicated on Drawings.
   b. Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour (meters per second) at 33 feet (10 m) above grade, according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 6.5, "Method 2- Analytical Procedure," based on mean roof heights above grade indicated on Drawings.

   1) Basic Wind Speed: 115 MPH
   2) Importance Factor: I.
   3) Exposure Category: C.

   c. Maximum Lateral Deflection: For the following types of glass supported on all 4 edges, provide thickness required that limits center deflection at design wind pressure to 1/50 times the short side length or 1 inch (25 mm), whichever is less, without damage.

   1) For monolithic-glass lites heat treated to resist wind loads.
   2) For insulating glass.

   d. Minimum Glass Thickness for Exterior Lites: Not less than 9/16 inch.
   e. Thickness of Tinted and Heat-Absorbing Glass: Provide the same thickness for each tint color indicated throughout Project.

C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:
1. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick of thickness indicated.

2. For laminated-glass lites, properties are based on products of construction indicated.

3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.

4. Center-of-Glass Values: Based on using LBL-44789 WINDOW 5.0 computer program for the following methodologies:
   a. U-Factors: NFRC 100 expressed as Btu/ sq. ft. x h x deg F (W/sq. m x K).

1.5 SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Samples: For the following products, in the form of 12-inch- (300-mm-) square Samples for glass.
   1. Interior door single glass lite.
   2. Insulating glass for each designation indicated.
   3. For each color (except black) of exposed glazing sealant indicated.

C. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.

D. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.
   1. For solar-control low-e-coated glass, provide documentation demonstrating that manufacturer of coated glass is certified by coating manufacturer.

E. Qualification Data: For installers.

F. Product Test Reports: For each of the following types of glazing products:
   1. Tempered glass.
   2. Insulating glass.

G. Warranties: Special warranties specified in this Section.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
B. Source Limitations for Glass: Obtain the following through one source from a single manufacturer for each glass type: clear float glass, coated float glass, laminated glass, glass-clad polycarbonate, and insulating glass.

C. Source Limitations for Glass Sputter-Coated with Solar-Control Low-E Coatings: Where solar-control low-e coatings of a primary glass manufacturer that has established a certified fabricator program is specified, obtain sputter-coated solar-control low-e-coated glass in fabricated units from a manufacturer that is certified by coated-glass manufacturer.

D. Source Limitations for Glazing Accessories: Obtain glazing accessories through one source from a single manufacturer for each product and installation method indicated.

E. Glazing for Fire-Rated Door Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252.

F. Glazing for Fire-Rated Window Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 257.

G. Safety Glazing Products: Comply with testing requirements in 16 CFR 1201 and, for wired glass, ANSI Z97.1.

   1. Subject to compliance with requirements, obtain safety glazing products permanently marked with certification label of the Safety Glazing Certification Council or another certification agency or manufacturer acceptable to authorities having jurisdiction.
   2. Where glazing units, including Kind FT glass and laminated glass, are specified in Part 2 articles for glazing lites more than 9 sq. ft. (0.84 sq. m) in exposed surface area of one side, provide glazing products that comply with Category II materials, for lites 9 sq. ft. (0.84 sq. m) or less in exposed surface area of one side, provide glazing products that comply with Category I or II materials, except for hazardous locations where Category II materials are required by 16 CFR 1201 and regulations of authorities having jurisdiction.

H. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.


I. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the following testing and inspecting agency:

   1. Insulating Glass Certification Council.
   2. Associated Laboratories, Inc.
1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. For insulating-glass units that will be exposed to substantial altitude changes, comply with insulating-glass manufacturer's written recommendations for venting and sealing to avoid hermetic seal ruptures.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F (4.4 deg C).

1.9 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form, made out to Owner and signed by coated-glass manufacturer agreeing to replace coated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form, made out to Owner and signed by laminated-glass manufacturer agreeing to replace laminated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

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

C. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form, made out to Owner and signed by insulating-glass manufacturer agreeing to replace insulating-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Basis-of-Design Product: The design for each glazing product is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 GLASS PRODUCTS

A. Annealed Float Glass: ASTM C 1036, Type I (transparent flat glass), Quality-Q3; of class indicated.

B. Heat-Treated Float Glass: ASTM C 1048; Type I (transparent flat glass); Quality-Q3; of class, kind, and condition indicated.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed, unless otherwise indicated.
2. Provide Kind HS (heat-strengthened) float glass in place of annealed float glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
3. For uncoated glass, comply with requirements for Condition A.
4. For coated vision glass, comply with requirements for Condition C (other uncoated glass).
5. Provide Kind FT (fully tempered) float glass in place of annealed or Kind HS (heat-strengthened) float glass where safety glass is indicated.

C. Insulating-Glass Units, General: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class CBA units and with requirements specified in this Article and in Part 2 "Insulating-Glass Units" Article.

1. Provide Kind HS (heat-strengthened) float glass in place of annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
2. Provide Kind FT (fully tempered) glass lites where safety glass is indicated.
3. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated for insulating-glass units are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.
4. Sealing System: Dual seal, with primary and secondary sealants as follows:
   a. Manufacturer's standard sealants.
   b. Polyisobutylene, silicone and structural silicone.
5. Spacer Specifications: Manufacturer's standard spacer material and construction.
6. Spacer Specifications: Manufacturer's standard spacer material and construction complying with the following requirements:
   a. Spacer Material: Aluminum with mill or clear anodic finish, Aluminum with black, color anodic finish, Aluminum with bronze, color anodic finish, Aluminum with powdered metal paint finish in color selected by Architect, Galvanized steel, or Stainless steel.
   b. Desiccant: Molecular sieve or silica gel, or blend of both.
   c. Corner Construction: Manufacturer's standard corner construction.
2.3 GLAZING SEALANTS

A. General: Provide products of type indicated, complying with the following requirements:

1. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers’ written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer’s full range.

B. Elastomeric Glazing Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

1. Single-Component Neutral- and Basic-Curing or Neutral-Curing Silicone Glazing Sealants:

   a. Available Products:

   1) Dow Corning Corporation; 993.
   2) GE Silicones; SilPruf SCS2000.
   3) Tremco; Spectrem 3

   b. Type and Grade: S (single component) and NS (nonsag).
   c. Class: 50.
   d. Use Related to Exposure: NT (nontraffic).
   e. Uses Related to Glazing Substrates: M, G, A, and, as applicable to glazing substrates indicated, O.

   1) Use O Glazing Substrates: Coated glass, color anodic aluminum, aluminum coated with a high-performance coating, galvanized steel, and wood.

2. Class 25 Neutral-Curing Silicone Glazing Sealant:

   a. Available Products:

   1) Dow Corning Corporation; 797.
   2) GE Silicones; UltraGlaze SSG4000.
   3) GE Silicones; UltraGlaze SSG4000AC.
   4) Polymeric Systems Inc.; PSI-631.
   6) Tremco; Proglaze SG.
   7) Tremco; Spectrem 2.
   8) Tremco; Tremsil 600.

   b. Type and Grade: S (single component) and NS (nonsag).
   c. Class: 25.
   d. Use Related to Exposure: NT (nontraffic).
2.4 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape, where indicated.
2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800 for the following types:

1. Type 1, for glazing applications in which tape acts as the primary sealant.
2. Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.5 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
2.6 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with outdoor and indoor faces.

C. Grind smooth and polish exposed glass edges and corners.

2.7 INSULATING-GLASS UNITS

A. Solar-Control Low-E Insulating-Glass Units IG: #1

1. Overall Unit Thickness: 1 inch.
2. Interspace/ Content: ½ inch/ ARGON
3. Indoor Lite: Ultra-Clear float glass complying with ceramic-coated vision-glass requirements.
   a. Tint Color: Ultra-Clear “Vitro” SOLARBAN R100 (2) CLEAR + CLEAR
   b. Kind FT (fully tempered).
   d. Thickness: ¼ inch
4. Outdoor Lite: Class 1 Ultra-clear float glass.
   a. Kind FT (fully tempered).
   b. Thickness: ¼ inch
5. Low-E Coating: Pyrolytic on third surface
6. Visible Light Transmittance: 54 percent minimum.
7. Winter Argon U-Factor: 0.24 maximum.
8. Solar Heat Gain Coefficient: 0.23 maximum.
9. VLR Exterior lite 13%
10. VLR: Interior lite 20%
11. Light to Solar Gain (LSG) 2.35
12. Basis-of-Design: “Vitro” Solarban R100 (2) CLEAR + CLEAR

2.8 INSULATING UNITS FOR INSULATED GLASS DOORS

A. Solar – Control Low-E Insulating Glass Units IG # 3

1. Overall thickness: 9/16 inch
2. Interspace content: ¼ inch/argon
3. Indoor Lite: Ultra-Clear float glass complying with ceramic coated vision glass requirements.
a. Tint Color: Ultra-Clear Solarban R100 (2) CLEAR + CLEAR  
b. Kind FT (fully tempered)  
c. Self cleaning, low maintenance coatings pyrolytic coating on first surface  
d. Thickness: 3/6 inch  

4. Outdoor Lite: Class I Ultra-Clear float glass  
a. Kind FT (Fully tempered)  
b. Thickness: 1/8 inch  

5. Low-E Coating: Pyrolytic on third surface  

6. Visible light transmittance: 54 percent maximum  

7. Basis-of-Design: “Vitro” Solarban R100 (2) CLEAR + CLEAR  

PART 3 - EXECUTION  

3.1 EXAMINATION  
A. Examine framing glazing, with Installer present, for compliance with the following:  
   1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.  
   2. Presence and functioning of weep system.  
   3. Minimum required face or edge clearances.  
   4. Effective sealing between joints of glass-framing members.  
B. Proceed with installation only after unsatisfactory conditions have been corrected.  

3.2 PREPARATION  
A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.  

3.3 GLAZING, GENERAL  
A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.  
B. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.  
C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge
damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm) as follows:
   1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
   2. Provide 1/8-inch (3-mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until just before each glazing unit is installed.
F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.
C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 088000
SECTION 088100

SPANDREL GLASS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD's Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section

1.2 SUMMARY

A. Section Includes: Monolithic ceramic enamel frit spandrel glass, ceramic enamel frit spandrel glass in insulating glass (IG) units.

B. Related Sections
   1. Drawings, General and Supplementary Conditions of the Contract, Division 1 and related sections.

1.3 REFERENCES

A. United States
   9. ASTM E1300 - Standard Practice for Determining the Minimum Thickness and Type of Glass Required to Resist a Specified Load.

1.4 DEFINITIONS

A. Sealed Insulating Glass Unit Surfaces & Coating Orientation:
   1. Surface 1 – Exterior surface of outer pane (surface facing outdoors of outboard lite).
   2. Surface 2 – Interior surface of outer pane (surface facing indoors of outboard lite).
   4. Surface 4 – Room side surface of inner pane (surfacing facing indoors of inboard lite).
B. Ceramic Enamel Frit Spandrel Glass: Glass that has been rendered opaque with a fired on ceramic enamel frit paint for non-vision applications.

1.5 SYSTEM DESCRIPTION

A. Design Requirements
   1. Provide glazing systems capable of withstanding normal thermal movements, windloads and impact loads, without failure, including loss due to defective manufacture, fabrication and installation; deterioration of glazing materials; and other defects in construction.
   2. Provide glass products in the thicknesses and strengths (annealed or heat-treated) required to meet or exceed the following criteria based on project loads and in-service conditions per ASTM E1300.
      a. Minimum thickness of annealed or heat-treated glass products is selected, so the worst-case probability of failure does not exceed the following:
         1) 8 breaks per 1000 for glass installed vertically or not over 15 degrees from the vertical plane and under wind action.
         2) 1 break per 1000 for glass installed 15 degrees or more from the vertical plane and under action of wind and/or snow.

1.6 SUBMITTALS

A. Submit 12-inch (305mm) square samples of each type of glass indicated (except clear monolithic glass products), and 12-inch (305mm) long samples of each color required (except black) for each type of sealant or gasket exposed to view.

B. Submit manufacturer's product data sheet and glazing instructions.

C. Glazing contractor shall obtain compatibility and adhesion test reports from sealant manufacturer, indicating that glazing materials were tested for compatibility and adhesion with glazing sealant, as well as other glazing materials including insulating units.

D. Glazing Contractor shall provide test reports showing that the glass meets the requirements of any security test reports specified on drawings.

1.7 QUALITY ASSURANCE

A. Safety glass products in the US are to comply with CPSC 16 CFR Part 1201 for Category II materials.

B. Insulating Glass products are to be permanently marked either on spacers or at least one insulating unit component with appropriate certification label of inspecting and testing agency indicated below:
   1. US - Insulating Glass Certification Council (IGCC)

C. Single-source fabrication responsibility: All glass fabricated for each type shall be processed and supplied by a single fabricator.

1.8 DELIVERY, STORAGE AND HANDLING

A. Comply with manufacturer's instruction for receiving, handling, storing and protecting glass & glazing materials.

B. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
C. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.

D. Exercise exceptional care to prevent edge damage to glass, and damage/deterioration to coating on glass.

E. Where insulating glass units will be exposed to substantial altitude changes, comply with insulating glass fabricator’s recommendations of venting and sealing.

1.9 PROJECT / SITE CONDITIONS

A. Environmental Requirements: Installation of glass products at ambient air temperature below 40 degrees F (4.4 degrees C) is prohibited.

B. Field Measurements: When construction schedule permits, verify field measurements with drawing dimensions prior to fabrication of glass products.

1.10 WARRANTY

A. Provide a written 10-year limited warranty from date of manufacture for insulating glass. Warranty covers deterioration due to normal conditions of use and not to handling, installing, protecting and maintaining practices contrary to glass manufacturer’s published instructions.

B. Provide a written minimum 5-year warranty from date of manufacture for ceramic enamel frit spandrel glass. Warranty covers deterioration due to normal conditions of use and not to handling installing, protecting and maintaining practices contrary to glass manufacturer’s published instructions.

C. Provide a written warranty from date of manufacture for tempered glass.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer is used in this section to refer to a firm that produces primary glass or fabricated glass as defined in the referenced standards.
   1. Oldcastle BuildingEnvelope®
   2. Guardian Industries
   3. Pilkington
   4. PPG Industries

2.2 MATERIALS

A. Monolithic Ceramic Enamel Frit Spandrel Glass
   1. Glass Type:
   2. Glass Tint:
   3. Nominal Thickness:
   4. Glass Strength: (Heat-Strengthened or Tempered)
   5. Coating Orientation: (N/A, Surface #1 or 2)
SPANDREL GLASS

6. Spandrel Orientation: Surface #2

7. Ceramic Enamel Frit Color Name and Number:

8. US Requirements:
   a. Heat-treated glass with ceramic coating complying with ASTM C1048, Condition B (spandrel glass, one surface ceramic-coated), Type I (transparent glass, flat), Quality Q3 (glazing select) and with other requirements as specified.
   b. GANA/GTA 66-9-20, Specification for Heat-Strengthened or Fully Tempered Ceramic Enameled Spandrel Glass for Use in Building Window/Curtain Walls and Other Architectural Applications.

D. Glazing Products
   1. Select appropriate glazing sealants, tapes, gaskets and other glazing materials of proven compatibility with other materials that they contact. These include glass products, insulating glass unit seals and glazing channel substrates under installation and service conditions, as demonstrated by testing and field experience.

PART 3 EXECUTION

3.1 EXAMINATION

A. Site Verification and Conditions
   1. Verify that site conditions are acceptable for installation of the glass.
   2. Verify openings for glazing are correctly sized and within tolerance.
   3. Verify that a functioning weep system is present.
   4. Verify that the minimum required face and edge clearances are being followed.
   5. Do not proceed with glazing until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protection
   1. Handle and store product according to manufacturers’ recommendations.

B. Surface Preparation
   1. Clean and prepare glazing channels and other framing members to receive glass.
   2. Remove coatings and other harmful materials that will prevent glass and glazing installation required to comply with performance criteria specified.

3.3 INSTALLATION

A. Install products using the recommendations of manufacturers of glass, sealants, gaskets and other glazing materials, except where more stringent requirements are indicated, including those in the “GANA Glazing Manual”.

B. Verify that Insulating Glass (IG) Unit secondary seal is compatible with glazing sealants.

C. Install glass in prepared glazing channels and other framing members.

D. Install setting blocks in rabbets as recommended by referenced glazing standards in GANA Glazing Manual and IGMA Glazing Guidelines.

E. Provide bite on glass, minimum edge and face clearances and glazing material tolerances recommended by GANA Glazing Manual.

F. Provide weep system as recommended by GANA Glazing Manual.
G. Set glass lites in each series with uniform pattern, draw, bow and similar characteristics.

H. Distribute the weight of the glass unit along the edge rather than at the corner.

I. Comply with manufacturer’s and referenced industry recommendations on expansion joints and anchors, accommodating thermal movement, glass openings, use of setting blocks, edge, face and bite clearances, use of glass spacers, edge blocks and installation of weep systems.

J. Protect glass from edge damage during handling and installation.

K. Prevent glass from contact with contaminating substances that result from construction operations, such as weld spatter, fireproofing or plaster.

L. Remove and replace glass that is broken, chipped, cracked or damaged in any way.

3.4 CLEANING

A. Clean excess sealant or compound from glass and framing members immediately after application, using solvents or cleaners recommended by manufacturers.

B. Glass to be cleaned according to:
   1. GANA Glass Informational Bulletin GANA 01-0300 - Proper Procedures for Cleaning Architectural Glass Products.
   2. GANA Glass Information Bulletin GANA TD-02-0402 – Heat-Treated Glass Surfaces Are Different.

C. Do not use scrapers or other metal tools to clean glass.

END OF SECTION 088100
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Interior gypsum wallboard.
   3. Sound Attenuating Blankets
   4. Cement backer board

B. Related Sections include the following:
   1. Division 5 Section 054000 "Cold-Formed Metal Framing" for load-bearing steel framing.
   2. Division 7 Section 072100 "Thermal Insulation" for insulation and air barrier system installed in gypsum board assemblies.
   3. Division 9 Section 093013 “Ceramic Tiling” for ceramic tiling installed over cement backer board.

1.3 DEFINITIONS

A. Gypsum Board Terminology: Refer to ASTM C 11 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

1.4 SUBMITTALS

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

B. Shop Drawings: Show locations, fabrication, and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other units of Work.

C. Samples: For the following products:
   1. Trim Accessories: Full-size sample in 12-inch- (300-mm-) long length for each trim accessory indicated.
2. Textured Finishes: Manufacturer's standard size for each textured finish indicated and on same backing indicated for Work.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.

B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat to prevent sagging.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, preference should be given to manufacturers offering products with sustainable components contributing to LEED certification, provide products by one of the following:

1. Steel Framing and Furring:
   a. Clark Steel Framing Systems.
   b. Consolidated Systems, Inc.
   d. Dietrich Industries, Inc.
   e. MarinoWare; Division of Ware Ind.
   g. Scafco Corporation.
   h. Unimast, Inc.
   i. Western Metal Lath & Steel Framing Systems.

2. Gypsum Board and Related Products:
   a. American Gypsum Co.
   b. G-P Gypsum Corp.
   c. National Gypsum Company.
   d. United States Gypsum Co.

2.2 STEEL PARTITION AND SOFFIT FRAMING

A. Components, General: As follows:
1. Comply with ASTM C 754 for conditions indicated.
2. Steel Sheet Components: Complying with ASTM C 645 requirements for metal and with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.

B. Steel Studs and Runners: ASTM C 645.
   1. Minimum Base Metal Thickness: 0.0179 inch (0.45 mm).
   2. Depth: 2 ½ inches 3-5/8 inches, 6 inches.
   3. Flexible Track: at curved walls only.

C. Deep-Leg Deflection Track: ASTM C 645 top runner with 2-inch (50.8-mm) deep flanges.

D. Proprietary Deflection Track: Steel sheet top runner manufactured to prevent cracking of gypsum board applied to interior partitions resulting from deflection of structure above; in thickness indicated for studs and in width to accommodate depth of studs.
   1. Available Product: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
      a. Delta Star, Inc., Superior Metal Trim; Superior Flex Track System (SFT).
      b. Metal-Lite, Inc.; Slotted Track.

E. Proprietary Firestop Track: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
   1. Product: Subject to compliance with requirements, provide one of the following:
      a. Fire Trak Corp.; Fire Trak attached to studs with Fire Trak Slip Clip.
      b. Metal-Lite, Inc.; The System.

F. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
   1. Minimum Base Metal Thickness 0.0312 inch (0.79 mm).

G. Cold-Rolled Channel Bridging: 0.0538-inch (1.37-mm) bare steel thickness, with minimum 1/2-inch (12.7-mm) wide flange.
   1. Depth: 1-1/2 inches (38.1 mm).
   2. Clip Angle: 1-1/2 by 1-1/2 inch (38.1 by 38.1 mm), 0.068-inch (1.73-mm) thick, galvanized steel.

H. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
   1. Minimum Base Metal Thickness: 0.0179 inch (0.45 mm).
   2. Depth: 7/8 inch (22.2 mm).
I. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (31.8 mm), wall attachment flange of 7/8 inch (22.2 mm), minimum bare metal thickness of 0.0179 inch (0.45 mm), and depth required to fit insulation thickness indicated.

J. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

2.3 INTERIOR GYPSUM WALLBOARD

A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.

   a. Thickness: 5/8 inch (15.9 mm).
   b. Long Edges: Tapered.
   c. Location: Vertical surfaces, unless otherwise required.

2.4 CEMENT BACKER UNITS

1. Use in wet areas.
2. Conform to ASTM C1325; Type A
3. Use in maximum lengths available to minimize end to end butt joints.

2.5 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.

2. Shapes:
   a. Cornerbead: Use at outside corners, unless otherwise indicated.
   b. Bullnose Bead: Use at outside corners where indicated.
   c. LC-Bead: J-shaped; exposed long flange receives joint compound; use at exposed panel edges.
   d. L-Bead: L-shaped; exposed long leg receives joint compound; use where indicated.
   e. U-Bead: J-shaped; exposed short flange does not receive joint compound; use at exposed panel edges where indicated.
   f. Expansion (Control) Joint: Use where indicated.
   g. Curved-Edge Cornerbead: With notched or flexible flanges; use at curved openings.
   h. Z-Reveal: exposed long leg receives joint compound; use where indicated.

B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Fry Reglet Corp.
   b. Gordon, Inc.
   c. MM Systems Corporation.
   d. Pittcon Industries.

2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), alloy 6063-T5.

3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.6 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475.

B. Joint Tape:
   1. Interior Gypsum Wallboard: Paper.

C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
   1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
   2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound, drying-type, all-purpose compound.
      a. Use setting-type compound for installing paper-faced metal trim accessories.
   3. Fill Coat: For second coat, use setting-type, sandable topping compound drying-type, all-purpose compound.
   4. Finish Coat: For third coat, use setting-type, sandable topping compound drying-type, all-purpose compound.
   5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound drying-type, all-purpose compound.

D. Joint compound for exterior gypsum wallboard applications: use setting-type taping compound and setting-type, sandable topping compound.

2.7 JOINT TREATMENT MATERIALS FOR CEMENT BACKER UNITS

A. Reinforcing Tape: Vinyl coated woven glass fiber mesh tape, open weave, 50 mm (2 inches) wide. Tape with pressure sensitive adhesive backing will not be permitted.

B. Tape Embedding Material: Latex-portland cement mortar complying with ANSI A108.01
TPWD Cedar Hill State Park Flood Repairs
TPWD No. 128269
HZ No. R302179.02

C. Joint material, including reinforcing tape, and tape embedding material, are to be as specifically recommended by the backer unit manufacturer.

2.8 ACOUSTICAL SEALANT

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

   1. Acoustical Sealant for Exposed and Concealed Joints:
      a. Pecora Corp.; AC-20 FTR Acoustical and Insulation Sealant.

   2. Acoustical Sealant for Concealed Joints:
      a. Ohio Sealants, Inc.; Pro-Series SC-170 Rubber Base Sound Sealant.
      b. Pecora Corp.; BA-98.

B. Acoustical Sealant for Exposed and Concealed Joints: Nonsag, paintable, nonstaining, latex sealant, with a VOC content of 250 g/L or less, complying with ASTM C 834 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

2.9 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

   1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.

D. Screws for Cement backer units

   1. Standard screws for gypsum board are not acceptable.
   2. Minimum 11 mm (7/16 inch) diameter head, corrosion resistant coated, with washers.
   3. ASTM C954 for steel 1 mm (0.033 inch) thick.
   4. ASTM C1002 for steel framing less than 0.0329 inch thick.

E. Washers for Cement backer units: Galvanized steel, 13 mm (1/2 inch) minimum diameter.

F. Isolation Strip at Exterior Walls:
1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

G. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

H. Thermal Insulation: As specified in Division 7 Section 072100 "Thermal Insulation."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLING STEEL FRAMING, GENERAL

A. Installation Standards: ASTM C 754, and ASTM C 840 requirements that apply to framing installation.

B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Comply with details indicated and with gypsum board manufacturer's written recommendations or, if none available, with United States Gypsum's "Gypsum Construction Handbook."

C. Install bracing at terminations in assemblies.

D. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement.

   1. Isolate ceiling assemblies where they abut or are penetrated by building structure.

   2. Isolate partition framing and wall furring where it abuts structure, except at floor. Install slip-type joints at head of assemblies that avoid axial loading of assembly and laterally support assembly.

      a. Use deep-leg deflection track where indicated.

E. Do not bridge building control and expansion joints with steel framing or furring members. Frame both sides of joints independently.
3.3 INSTALLING FURRED AND SUSPENDED CEILINGS AND SOFFITS

A. Install furred and suspended ceilings or soffits in accordance with ASTM C754 or ASTM C841 except as otherwise specified or shown for screw attached gypsum board ceilings and for plaster ceilings or soffits.

1. Space framing at 24-inch o.c. for gypsum board anchorage.

B. Where bar joists or beams are more than 48 inches apart, provide intermediate hangers so that spacing between supports does not exceed 48 inches. Use clips, bolts, or wire ties for direct attachment to steel framing.

C. Steel decking without concrete topping:

1. Do not fasten to steel decking 0.76 mm (0.0299-inch) or thinner.
2. Toggle bolt to decking 0.9 mm (0.0359-inch) or thicker only where anchorage to steel framing is not possible.

D. Installing suspended ceiling system for gypsum board (ASTM C635):

1. Install only for ceilings to receive screw attached gypsum board.
2. Install in accordance with ASTM C636.
   a. Install main runners spaced 48 inches on center.
   b. Install four foot tees not over 24 inches on center; locate for edge support of gypsum board.
   c. Install wall track channel at perimeter.

3.4 INSTALLING STEEL PARTITIONS

A. Install tracks (runners) at floors, ceilings, and structural walls and columns where gypsum board assemblies abut other construction.

B. Installation Tolerance: Install each steel framing and furring member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by the faces of adjacent framing.

C. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.

1. Cut studs 1/2 inch (13 mm) short of full height to provide perimeter relief.
2. For fire-resistance-rated and STC-rated partitions that extend to the underside of floor/roof slabs and decks or other continuous solid-structure surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed to support gypsum board closures and to make partitions continuous from floor to underside of solid structure.
   a. Terminate partition framing at suspended ceilings where indicated.
D. Install steel studs and furring at the following spacings:
   2. Multilayer Construction: 24 inches o.c., unless otherwise indicated.
   3. Tile Backing Panels: 16 inches o.c., unless otherwise indicated.

E. Install steel studs so flanges point in the same direction and leading edge or end of each panel can be attached to open (unsupported) edges of stud flanges first.

F. Frame door openings to comply with GA-600 and with gypsum board manufacturer's applicable written recommendations, unless otherwise indicated. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
   1. Install two studs at each jamb, unless otherwise indicated.
   2. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint.
   3. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above.

G. Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

H. Install to comply with requirements specified in Division 7 Section 072100 "Thermal Insulation."

3.5 APPLYING AND FINISHING PANELS, GENERAL

A. Gypsum Board Application and Finishing Standards: ASTM C 840 and GA-216.

B. Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.

C. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

D. Install gypsum panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.

E. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

F. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
G. Attach gypsum panels to framing provided at openings and cutouts.

H. Form control and expansion joints with space between edges of adjoining gypsum panels.

I. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by coffers, joists, and other structural members; allow 1/4- to 3/8-inch-(6.4- to 9.5-mm-) wide joints to install sealant.

J. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch-(6.4- to 12.7-mm-) wide spaces at these locations, and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

K. Floating Construction: Where feasible, including where recommended in writing by manufacturer, install gypsum panels over wood framing, with floating internal corner construction.

L. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.

1. Space screws a maximum of 12 inches (304.8 mm) o.c. for vertical applications.

M. Space fasteners in panels that are tile substrates a maximum of 8 inches (203.2 mm) o.c.

3.6 PANEL APPLICATION METHODS

A. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.
2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

   a. Stagger abutting end joints not less than one framing member in alternate courses of board.
   b. At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.
3. On furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
B. Multilayer Application on Ceilings: Apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints 1 framing member, 16 inches (400 mm) minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.

C. Multilayer Application on Partitions/Walls: Apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.

1. Furring Members: Apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.

D. Single-Layer Fastening Methods: Apply gypsum panels to supports with steel drill screws.

E. Multilayer Fastening Methods: Fasten base layers with screws; fasten face layers with adhesive and supplementary fasteners.

F. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.7 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints at locations indicated on Drawings and according to ASTM C 840 and in specific locations approved by Architect for visual effect.

3.8 FINISHING GYPSUM BOARD ASSEMBLIES

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints, rounded edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840, for locations indicated:
1. Level 1: Embed tape at joints in ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.

2. Level 2: Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges where panels are substrate for tile and where indicated.

3. Level 4: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at panel surfaces that will be exposed to view at typical area, unless otherwise indicated.

END OF SECTION 092600
CERAMIC TILING

SECTION 093013

CERAMIC TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Ceramic mosaic tile.
2. Porcelain tile.
3. Waterproof membrane.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
2. Section 092600 "Gypsum Board Assemblies" for cement backer board substrate installed with ceramic tiling.

1.3 DEFINITIONS

A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.


C. Module Size: Actual tile size plus joint width indicated.

D. Face Size: Actual tile size, excluding spacer lugs.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

C. Samples for Verification:
   1. Full-size units of each type and composition of tile and for each color and finish required.
   2. Full-size units of each type of trim and accessory for each color and finish required.

1.5 INFORMATIONAL SUBMITTALS
   A. System Warranty: Submit manufacturer's warranty information.

1.6 QUALITY ASSURANCE
   A. Provide 25-year system warranty on tile setting systems for tiled assembly, equivalent to Laticrete "25 Year System Warranty".

1.7 DELIVERY, STORAGE, AND HANDLING
   A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
   B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
   C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
   D. Store liquid materials in unopened containers and protected from freezing.

1.8 FIELD CONDITIONS
   A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.
      1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.

1. Obtain setting and grouting materials from single manufacturer.
2. Obtain waterproof membrane from manufacturer of setting and grouting materials.

2.2 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

1. Provide tile complying with Standard grade requirements unless otherwise indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.

1. Where tile is indicated for installation on exteriors or in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.

2.3 TILE PRODUCTS (TL-2)

A. Ceramic Tile Types

1. **Products**: “Daltile” Rittenhouse Square (3x6)
   
   b. Grout Color: as selected by Architect from manufacturer’s full range.
   c. Special Shape: Manufacturer’s standard bullnose corners and cove base tiles

2.4 SETTING MATERIALS

A. Latex-Portland Cement Mortar (Thinset): ANSI A118.4.

1. **Basis-of-Design Product**: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. Custom Building Products.
   b. LATICRETE SUPERCAP, LLC “254 Platinum” (Basis of Design).
   c. MAPEI Corporation; Granirapid® System.
2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

2.5 GROUT MATERIALS

A. Water-Cleanable Epoxy Grout: ANSI A118.3, with a VOC content of 65 g/L or less for All Tile Work.

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   
   a. Custom Building Products "CEG-IG 100% Solids Industrial Grade Epoxy Grout".
   b. LATICRETE SUPERCAP, LLC "Spectralock Pro Premium" (Basis of Design).
   c. MAPEI Corporation; Kerapoxy®.

2. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 and 212 deg F (60 and 100 deg C), respectively, and certified by manufacturer for intended use.

2.6 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

2.7 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers’ written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other
substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.

2. Verify that concrete substrates for tile floors installed with bonded mortar bed comply with surface finish requirements in ANSI A108.01 for installations indicated.
   a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
   b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.

3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.

4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

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

3.2 PREPARATION

A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot (1:50) toward drains.

C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 CERAMIC TILE INSTALLATION

A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
   a. All tile work.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight
aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.

F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:

1. 1/8 inch typical or as recommended by manufacturer.

H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

3.4 ADJUSTING AND CLEANING

A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.

B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove grout residue from tile as soon as possible.
2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
3.5 PROTECTION

A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.6 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

A. Interior Wall Installations, over cement backer board:

1. Ceramic Tile Installation, typical including tops of walls; thinset mortar, over cement backer board on metal studs.
   a. Ceramic Tile Type: Glazed.
   c. Grout: Water-cleanable epoxy grout.

END OF SECTION 093013
SECTION 095100
ACOUSTICAL PANEL CEILING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
B. Section Includes:
   1. Cementitious wood fiber plank acoustical ceiling system.

1.3 REFERENCES
A. American Society for Testing and Materials (ASTM):
   1. ASTM A 1008 Standard Specification for Steel, Sheet, Cold Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
   4. ASTM C 423 Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
   7. ASTM E 580 Installation of Metal Suspension Systems in Areas Requiring Moderate Seismic Restraint
   8. ASTM E 1414 Standard Test Method for Airborne Sound Attenuation between Rooms Sharing a Common Ceiling Plenum
9. ASTM E 1264 Classification for Acoustical Ceiling Products


D. NFPA 70 National Electrical Code.


J. L.E.E.D. - Leadership in Energy and Environmental Design is a set of rating systems for the design, construction, operation, and maintenance of green buildings.

1.4 SYSTEM DESCRIPTION

A. Direct Attach Ceilings.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical data for each type of Direct-Attached™ ceilings required.

B. Samples: Minimum 6 inch x 6 inch samples of specified Direct-Attached acoustical ceilings panel.

C. Shop Drawings: Layout and details of Direct-Attached wall panels show locations of items that are to be coordinated with the installation.

D. Certifications: Manufacturer's certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and standards. For acoustical performance, products must be tested to the A, D-20, C-20, or C-40 method.

E. If the material supplied by the acoustical subcontractor does not conform to manufacturer's current published values as specified in 2.2 of this specification, the material must be removed, disposed of, and replaced with complying product at the expense of the Contractor performing the work.
1.6 QUALITY ASSURANCE

A. Single-Source Responsibility: Provide acoustical panel units.

B. Fire Performance Characteristics: Identify acoustical ceiling components with appropriate markings of applicable testing and inspecting organization.

1. Surface Burning Characteristics: As follows, tested per ASTM E 84 and complying with ASTM E 1264 Classification.

C. Coordination of Work: Coordinate acoustical ceiling work with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver acoustical ceiling units to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.

B. Provide labels indicating brand name, style, size and thickness.

C. Before installing acoustical ceiling units, permit them to reach room temperature and a stabilized moisture content.

D. Handle acoustical ceiling units carefully to avoid chipping edges or damaged units in any way.

1.8 PROJECT CONDITIONS

A. Environmental Requirements:

B. Do not install ceiling panels until building is closed in and HVAC system is operational.

C. Locate materials onsite at least 24 hours before beginning installation to allow materials to reach temperature and moisture content equilibrium.

D. Maintain the following conditions in areas where acoustical materials are to be installed 24 hours before, during and after installation:

1. Relative Humidity: 65 - 75%.


1.9 WARRANTY

A. Direct attached acoustical ceiling panels: Submit a written warranty executed by the manufacturer, agreeing to repair or replace panels that fail within the warranty period. Failures include, but are not limited to the following:
TPWD Cedar Hill State Park Flood Repairs
TPWD No. 128269
HZ No. R302179.02

ACOUSTICAL PANEL CEILINGS

1. Sagging and warping

B. Direct attached ceiling panels one source manufacturer is Thirty (30) years from date of substantial completion.

C. The Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

1.10 MAINTENANCE

A. Extra Materials: Deliver extra materials to Owner. Furnish extra materials described below that match products installed. Packaged with protective covering for storage and identified with appropriate labels.

1. Furnish quality of full-size units equal to 5.0 percent of amount installed.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Acoustical Ceiling Panels:


2. Enviroacoustic Wood Wool by Acoustical Surfaces, Inc.

2.2 CEMENTITIOUS WOOD FIBER CEILING PANELS (WFC-1)

A. Acoustical Ceiling Panels:

1. Surface Texture: Coarse

2. Composition: Aspen wood fibers bonded with inorganic hydraulic cement

3. Color: As indicated in drawings

4. Size: 23-3/4 in x 48 in

5. Thickness: 1 in

6. Edge Profile: Long beveled edge

7. Noise Reduction Coefficient (NRC): 0.40

8. Flame Spread: ASTM E 1264; Class A

10. Dimensional Stability: HumiGuard Plus

11. Sustainable: EPD (Environmental Product Declaration) and HPD (Health Product Declaration)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not proceed with installation until all wet work such as concrete, plastering and painting has been completed and thoroughly dried out, unless expressly permitted by manufacturer's printed recommendations.

3.2 PREPARATION

A. Measure each wall area and establish layout of wall units. Coordinate panel layout with mechanical and electrical fixtures.

B. Coordination: Furnish layouts for preset inserts, clips, and other ceiling anchors whose installation is specified in other sections.

1. Furnish concrete inserts and similar devices to other trades for installation well in advance of time needed for coordination of other work.

3.3 INSTALLATION

A. Install ceiling panels in accordance to manufacturer's direct attachment installation instructions.

3.4 ADJUSTING AND CLEANING

A. Replace damaged and broken Direct-Attached Ceiling Panels.

B. Clean exposed surfaces of acoustical ceilings. Comply with manufacturer's instructions for cleaning and touch up of minor finish damage. Remove any ceiling panels that cannot be successfully cleaned and or repaired. Replace with attic stock or new product to eliminate evidence of damage.

END OF SECTION 095100
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. Resilient base.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer’s standard-size Samples, but not less than 12 inches long.

1.4 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.6 FIELD CONDITIONS
B. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following periods:
   1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

C. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

D. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 THERMOSET-RUBBER BASE (B-1)

A. Product Standard: ASTM F 1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).

   1. Style and Location:
      a. Style B, Cove

B. Thickness: 0.125 inch.

C. Height: 4 inches.

D. Lengths: Coils in manufacturer's standard length but not less than 100 feet.

E. Outside Corners: Preformed.

F. Inside Corners: Job-formed or preformed.

G. Colors: As indicated by manufacturer's designations.

2.2 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, Portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

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

1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

C. Do not install resilient products until materials are the same temperature as space where they are to be installed.

1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.

D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Perform the following operations immediately after completing resilient-product installation:
1. Remove adhesive and other blemishes from surfaces.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513
SECTION 096700
RESINOUS FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes one resinous flooring system which includes a penetrating two-component epoxy primer, four-component mortar consisting of epoxy resin, curing agent and finely graded quartz silica aggregate, three-component, epoxy undercoat, brightly colored, quartz silica aggregate broadcast and a high performance, two-component, clear epoxy sealer.

1. Application Method: Troweled mortar, undercoat, broadcast quartz aggregate and seal.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.
B. Samples for Verification: For each resinous flooring system required, 6 inches (150 mm) square, applied to a rigid backing by Installer for this Project.
C. Product Schedule: Use resinous flooring designations indicated in Part 2 and room designations indicated on Drawings in product schedule.
D. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.
E. Maintenance Data: For resinous flooring to include in maintenance manuals.

1.4 QUALITY ASSURANCE
A. Installer Qualifications: Engage an experienced installer (applicator) who is experienced in applying resinous flooring systems similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance, and who is acceptable to resinous flooring manufacturer.
1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.
2. Contractor shall have completed at least 10 projects of similar size and complexity.

B. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, through one source from a single manufacturer, with not less than ten years of successful experience in manufacturing and installing principal materials described in this section. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.

C. Manufacturer Field Technical Service Representatives: Resinous flooring manufacture shall retain the services of Field Technical Service Representatives who are trained specifically on installing the system to be used on the project.

1. Field Technical Services Representatives shall be employed by the system manufacture to assist in the quality assurance and quality control process of the installation and shall be available to perform field problem solving issues with the installer.

D. Mockups: Apply mockups if needed to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Apply full-thickness mockups if needed on 48-inch- (1200-mm-) square floor area selected by Architect.
   a. Include 48-inch (1200-mm) length of integral cove base.

2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

B. Store materials to prevent deterioration from moisture, heat, cold, direct sunlight, or other detrimental effects.

C. All materials used shall be factory pre-weighed and pre-packaged in single, easy to manage batches to eliminate on site mixing errors. No on site weighing or volumetric measurements allowed.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.

1. Maintain material and substrate temperature between 65 and 85 deg F (18 and 30 deg C) during resinous flooring application and for not less than 24 hours after application.

B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.
C. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application, unless manufacturer recommends a longer period.

D. Concrete substrate shall be properly cured for a minimum of 30 days. A vapor barrier must be present for concrete subfloors on or below grade. Otherwise, an osmotic pressure resistant grout must be installed prior to the resinous flooring.

1.7 WARRANTY

A. Manufacturer shall furnish a single, written warranty covering both material and workmanship for a period of (1) full years from date of installation, or provide a joint and several warranty signed on a single document by material manufacturer and applicator jointly and severally warranting the materials and workmanship for a period of (1) full year from date of installation. A sample warranty letter must be included with bid package or bid may be disqualified.

PART 2 - PRODUCTS

2.1 RESINOUS FLOORING (RF-1)

A. Available Products: Subject to compliance with requirements of the following: a penetrating two-component epoxy primer, four-component 3/16\textsuperscript{th} inch mortar consisting of epoxy resin, curing agent and finely graded quartz silica aggregate, three-component, epoxy undercoat, brightly colored, quartz silica aggregate broadcast and a high performance, two-component, clear epoxy sealer. Liquid rich systems and or builds of slurries and non troweled mortar systems will be rejected.

1. Basis of design: “Stonshield HRI” by Stonhard
2. Arizona Polymers
3. “Hybri-Flex EQ” by Dur-A-Flex

B. System Characteristics:

1. Color and Pattern: As indicated on drawings
2. Wearing Surface: Medium texture as selected from manufacturer.
3. Integral Cove Base: 6 inch cove base
4. Overall System Thickness: 3/16 inch (5 mm).

C. System Components: Manufacturer’s standard components that are compatible with each other and as follows:

1. Standard Primer
   a. Material Basis: Bisphenol A Epoxy Primer

2. Body Coat(s):
   a. Material Basis: HRI Mortar Base is a four component troweled epoxy mortar consisting of epoxy resin, curing agent and finely graded aggregate.
   b. Resin: Epoxy.
3. Undercoat and broadcast quartz:
   a. Resin: three component free flowing epoxy that includes resin, curing agent, and
      manufacturer’s compatible aggregate.
   b. Formulation Description: 100% solids.
   c. Number of Coats: 1

4. Topcoat:
   a. Material Basis: (Basis of Design) Stonseal CE4
   b. Resin: high performance UV resistant, clear epoxy sealer
   c. Two component
   d. Number of Coats: 1

2.2 ACCESSORY MATERIALS

A. Primer: Type recommended by manufacturer for substrate and body coats indicated.
   Formulation Description: Manufacturer’s Standard Primer, 100% solids.

B. Waterproofing Membrane: Manufacturer will suggest compatible positive side waterproofing
   where needed. Patching and Fill Material: Resinous product of or approved by resinous
   flooring manufacturer and recommended by manufacturer for application indicated.

C. Joint Sealant: Type recommended or produced by resinous flooring manufacturer for type of
   service and joint condition indicated. Allowances should be included for manufacturer’s joint fill
   material, and or CT5 concrete crack treatment.

PART 3 - EXECUTION

3.1 PREPARATION

A. General: Prepare and clean substrates according to resinous flooring manufacturer’s written
   instructions for substrate indicated. Provide clean, dry, and neutral Ph substrate for resinous
   flooring application.

B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence,
   curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants
   incompatible with resinous flooring.
   1. Mechanically prepare substrates as follows:
      a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains
         the dispensed shot within the apparatus, and recirculates the shot by vacuum
         pickup. Hand grinding where needed with hepavac as required.
      b. Comply with ASTM C 811 requirements, unless manufacturer’s written instructions
         are more stringent.
   2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's
      written recommendations.
   3. Verify that concrete substrates are dry with one of methods below (A,B,C).
a. Perform in situ probe test, ASTM F 2170. Proceed with application only after substrates do not exceed a maximum potential equilibrium relative humidity of 75 percent.

b. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with application only after substrates have maximum moisture-vapor-emission rate of 6 lb of water/1000 sq. ft. of slab in 24 hours.

c. Perform additional moisture tests recommended by manufacturer. Proceed with application only after substrates pass testing.

4. Verify that concrete substrates have neutral Ph and that resinous flooring will adhere to them. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.

C. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer’s written instructions.

D. Use patching and fill material to fill holes and depressions in substrates according to manufacturer’s written instructions.

E. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer’s written recommendations. Allowances should be included for manufacturer’s joint fill material, and CT5 concrete crack treatment.

3.2 APPLICATION

A. General: Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform wearing surface of thickness indicated.

1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.

2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.

3. At substrate expansion and isolation joints, provide joint in resinous flooring to comply with resinous flooring manufacturer's written recommendations.

   a. Apply joint sealant to comply with manufacturer’s written recommendations.

B. Apply primer where required by resinous system, over prepared substrate at manufacturer's recommended spreading rate.

A. Integral Cove Base: Manufacturer’s cove base mortar (No Broadcasted cove base accepted), apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details including those for taping, mixing, priming, troweling, sanding, and topcoating of cove base. Round internal and external corners.

   1. Integral Cove Base: 6 inches high.

B. Troweled Mortar: Mix mortar material according to manufacturer's recommended procedures. Uniformly spread mortar over substrate using manufacturer's specially designed screed box adjusted to manufacturer's recommended height. Hand trowel apply mixed material over freshly primed substrate using steel finishing trowels or power trowel material using manufacturer's specially designed power trowel blades.
RESINOUS FLOORING

3.3 TERMINATIONS

A. Chase edges to “lock” the coating system into the concrete substrate along lines of termination.

B. Penetration Treatment: Lap and seal coating onto the perimeter of the penetrating item by bridging over compatible elastomer at the interface to compensate for possible movement.

C. Trenches: Continue coating system into trenches to maintain monolithic protection. Treat cold joints to assure bridging of potential cracks.

D. Treat floor drains by chasing the coating to lock in place at point of termination.

3.4 JOINTS AND CRACKS

A. Treat control joints to bridge potential cracks and to maintain monolithic protection.

B. Treat cold joints and construction joints to bridge potential cracks and to maintain monolithic protection on horizontal and vertical surfaces as well as horizontal and vertical interfaces.

C. Discontinue floor coating system at vertical and horizontal contraction and expansion joints by installing backer rod and compatible sealant after coating installation is completed. Provide sealant type recommended by manufacturer for traffic conditions and chemical exposures to be encountered.

3.5 FIELD QUALITY CONTROL

A. Material Sampling: Owner may at any time and any numbers of times during resinous flooring application require material samples for testing for compliance with requirements.

1. Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.

2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer’s product data.

3. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reapply flooring materials to comply with requirements.
3.6 CLEANSING, PROTECTING, AND CURING

A. Cure resinous flooring materials in compliance with manufacturer's directions, taking care to prevent contamination during stages of application and prior to completion of curing process. Close area of application for a minimum of 18 hours.

B. Protect resinous flooring materials from damage and wear during construction operation. Where temporary covering is required for this purpose, comply with manufacturer's recommendations for protective materials and method of application. General Contractor is responsible for protection and cleaning of surfaces after final coats.

C. Cleaning: Remove temporary covering and clean resinous flooring just prior to final inspection. Use cleaning materials and procedures recommended by resinous flooring manufacturer.
SECTION 099000
PAINTS AND COATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes surface preparation and application of high-performance coating systems on the following substrates:

1. Surface preparation and field application of exterior high-performance coating systems to items and surfaces scheduled:
   a. Concrete masonry units (CMU).
   b. Steel.
   c. Galvanized metal.

2. Surface preparation and field application of interior high-performance coating systems to items and surfaces scheduled.
   a. Steel
   b. Galvanized metal

3. Surface preparation and field painting of exposed interior items and surfaces:
   a. Gypsum board.

B. Related Sections include the following:

1. Division 04 Section 042200 Concrete Masonry Unit
2. Division 05 Section 051200- Structural Steel, Section 055000 Miscellaneous Metal.
3. Division 09 Section 092600 – Gypsum Board Assemblies

1.3 SUBMITTALS

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

B. Samples for Initial Selection: For each type of finish-coat product indicated.

C. Samples for Verification: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns.
D. **Product List:** For each product indicated. Cross-reference products to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules.

1.4 **QUALITY ASSURANCE**

A. **Master Painters Institute (MPI) Standards:**

1. **Products:** Complying with MPI standards indicated and listed in "MPI Approved Products List."
2. **Preparation and Workmanship:** Comply with requirements in "MPI Architectural Painting Specification Manual" for products and coating systems indicated.

B. Obtain block fillers and primers for each coating system from the same manufacturer as the finish coats.

C. Paint exposed surfaces. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If a color of finish is not indicated, Architect will select from standard colors and finishes available.

D. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.

1.5 **DELIVERY, STORAGE, AND HANDLING**

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 **PROJECT CONDITIONS**

A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1.7 **EXTRA MATERIALS**

A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.

1. **Quantity:** Furnish an additional 5 percent, but not less than 2 gal. (7.6 L) of each material and color applied.
2.1 PAINT MATERIALS, GENERAL

A. Material Compatibility:

1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. Provide products of same manufacturer for each coat in a coating system.
3. Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. VOC Classification: Provide high-performance coating materials, including primers, undercoats, and finish-coat materials, that meet the applicable local, state or federal VOC requirements.

C. Colors: As indicated on finish schedule in the drawings.

2.2 INTERIOR PAINT SYSTEMS

A. Gypsum Board: Provide the following finish systems over interior gypsum board surfaces

1. Acrylic Finish: Two finish coats over a primer.
   a. Primer-Zero VOC: PPG Paints; Speedhide zero Interior Zero VOC Latex Primer 6-4900Xl: Applied at a dry film thickness of not less than 1.2 mils (0.029 mm)
   b. Interior flat acrylic finish-Zero VOC: PPG Paints; 6-4110XI Speedhide zero Interior Zero VOC Flat Latex: Applied at a dry film thickness of not less than 1.4 mils (0.035 mm)

2.3 EXTERIOR HIGH PERFORMANCE COATING SYSTEMS

A. Concrete Masonry Units: Provide the following finish systems over exterior concrete masonry block:

1. Semigloss Finish: One finish coat over an intermediate coat and a block filler.
      1) PPG; Amerlock 400BF Epoxy Block Filler.
   b. Intermediate Coat: Epoxy Coating applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 4.0 to 6.0 mils.
      1) PPG; 95-245 Series Pitt-Guard Rapid Coat DTR Polyamide Epoxy Coating.
   c. Topcoat: Semigloss, aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils.

B. Ferrous Metal: Provide the following finish systems over exterior ferrous-metal surfaces:

1. Semigloss Finish: One finish coat over an intermediate coat and a primer.
   a. Primer: Epoxy primer.
      1) PPG; 95-245 Series Pitt-Guard Rapid Coat DTR Polyamide Epoxy Coating.
   b. Intermediate Coat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils.
      1) PPG; 95-8800 Series Pitthane High Build Semi-Gloss Urethane Enamel.
c. Topcoat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 to 5.0 mils
   1) PPG; 95-8800 Series Pitthane High Build Semi-Gloss Urethane Enamel.

2.4 INTERIOR PAINT SYSTEMS

A. Ferrous Metal: Provide the following finish systems over interior ferrous-metal surfaces:
   1. Semigloss Finish: One finish coat over an intermediate coat and a primer.
      a. Primer: Epoxy primer.
         1) PPG; 95-245 Series Pitt-Guard Rapid Coat DTR Polyamide Epoxy Coating at 5.0 to 7.0 dry film thickness.
      b. Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 4.0 to 6.0 mils
         1) PPG; 97-130 Series Aquapon High Build Semi-Gloss Polyamide Epoxy Coating.
      c. Topcoat: Semigloss epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 4.0 to 6.0 mils
         1) PPG; 97-130 Series Aquapon High Build Semi-Gloss Polyamide Epoxy Coating.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.

   1. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
      a. Masonry (CMU): 12 percent.
      b. Gypsum Board: 12 percent.

   2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

   3. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

   4. Coating application indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
1. After completing coating operations, reinstall items that were removed; use workers skilled in the trades involved.

C. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, and incompatible paints and encapsulants.

   1. Remove incompatible primers and reprime substrate with compatible primers as required to produce coating systems indicated.

D. CMU Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.

E. Steel Substrates: Remove rust and loose mill scale.

   1. Clean using methods recommended in writing by coating manufacturer.
   2. Blast clean according to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning"
   3. Galvanized-metal substrates should not be chromate passivated (commercially known as "bonderized"). If galvanized metal is chromate passivated, consult manufacturers for appropriate surface preparation and primers.
   4. Clean ungalvanized ferrous-metal surfaces that have not been shop coated

F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.

G. Nonferrous-Metal Substrates: Clean nonferrous and galvanized surfaces according to manufacturer's written instructions for the type of service, metal substrate, and application required.

   1. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

H. Material Preparation: Carefully mix and prepare coating materials according to manufacturer's written instructions.

   1. Maintain containers used in mixing and applying coatings in a clean condition, free of foreign materials and residue.
   2. Stir materials before applying to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into the material. Remove film and, if necessary, strain coating material before using.
   3. Use only the type of thinners approved by manufacturer and only within recommended limits.

3.3 APPLICATION

A. Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied

B. Apply high-performance coatings according to manufacturer's written instructions.

   1. Use applicators and techniques suited for coating and substrate indicated.
   2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

C. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

D. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.

E. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 FIELD QUALITY CONTROL

A. Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when coatings are being applied:

1. Owner will engage the services of a qualified testing agency to sample coating material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.

2. Testing agency will perform tests for compliance with specified requirements.

3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with specified requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

END OF SECTION 099000
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Fabricated channel dimensional characters on Group Recreation Hall exterior elevation 1/A201.
   2. Fabricated channel dimensional gender symbol on Comfort Station No.7 exterior elevation 2/A251
   3. Corten steel trail marking letters imbedded within shoreline trail.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For signs.
   1. Include fabrication and installation details and attachments to other work.
   2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
   3. Show message list, typestyles, graphic elements, and layout for each sign at least half size.

C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.
   1. Include representative Samples of available typestyles and graphic symbols.

D. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
   1. Dimensional Characters: Quarter size Sample of each type of dimensional character.
   2. Exposed Accessories: Half-size Sample of each accessory type.
E. Product Schedule: For dimensional letter signs. Use same designations indicated on Drawings or specified.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify locations in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

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

   a. Deterioration of finishes beyond normal weathering.

   b. Separation or delamination of sheet materials and components.

Verify available warranties and warranty periods for units and components.

2. Warranty Period: Five years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 “Quality Requirements,” to design sign structure and anchorage of dimensional character sign type(s) according to structural performance requirements.

B. Structural Performance: Signs and supporting elements shall withstand the effects of gravity and other loads within limits and under conditions indicated.

C. Thermal Movements: For exterior fabricated channel dimensional characters, allow for thermal movements from ambient and surface temperature changes.

Differential values in “Temperature Change” Subparagraph below (for aluminum in particular) are suitable for most of the United States.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 DIMENSIONAL CHARACTERS

A. Fabricated Channel Characters Metal face and side returns formed free from warp and distortion; with uniform faces, sharp corners, and precisely formed lines and profiles; internally braced for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners; and as follows.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. ASI Signage Innovations.
   b. ESBEE Sign systems.

2. Character Material: Sheet or plate aluminum.

3. Material Thickness: Manufacturer’s standard for size and design of character and symbol.
   a. Sheet Thickness: Manufacturer’s standard thickness for size of character and symbol.

4. Character Height: As indicated on Drawings.

5. Character Depth: As indicated on Drawings.

6. Finishes:
   a. Brushed No.4 Aluminum Finish
   b. Overcoat: Clear organic coating.

7. Mounting: Manufacturer’s standard for size and design of character.
   a. Hold characters at 1-inch (25-mm) distance from wall surface.

8. Typeface: Trade Gothic LT Com Bold Cn.
B. Cut Trail Marking Letters and Characters Metal face and side returns formed free from warp and distortion; with uniform faces, sharp corners, and precisely formed lines and profiles; internally braced for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners; and as follows.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Impactsigns.com
   b. Signlettersource.com
   c. Or approved Equal

2. Character Material: Rusted Corten Steel.

3. Material Thickness: Sheet Thickness: Manufacturer's standard thickness for size of character and symbol.

4. Character Height: 6 inches.
5. Character Depth: ¼”.
6. Finishes:
   a. None

7. Mounting: Manufacturer's standard stud mounting.
   Characters shall be mounted flush with paving surface.

8. Typeface: Arial.

2.3 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:

1. Use concealed fasteners and anchors unless indicated to be exposed.
2. For exterior exposure, furnish stainless-steel devices unless otherwise indicated.
3. Exposed Metal-Fastener Components, General:
   a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
   b. Fastener Heads: For nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant one-way-head slots unless otherwise indicated.

4. Sign Mounting Fasteners:
   a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
DIMENSIONAL LETTER AND SYMBOL SIGNAGE

b. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.

c. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, installed in predrilled holes.

2.4 FABRICATION

A. General: Provide manufacturer’s standard sign assemblies according to requirements indicated.

1. Preassemble assemblies in the shop to greatest extent possible. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.

2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.

3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.

4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.

5. Internally brace dimensional characters for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.

6. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

B. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer’s standard brackets as required.

1. Stainless-Steel Brackets: Factory finish brackets with No. 4 finish unless otherwise indicated.

2.5 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.

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

3.2 INSTALLATION

Retain mounting methods in this article that coordinate with mounting requirements in sign-description paragraphs retained in Part 2.

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Mounting Methods:

1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
   a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.

3.3 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed characters and signs that do not comply with specified requirements. Replace characters with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.
C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.
SECTION 101423

PANEL SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic panel room-identification and other signs.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For panel signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.

C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.

1. Include representative Samples of available typestyles and graphic symbols.

D. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:

1. Room-Identification Signs: Full-size Sample.
2. Variable Component Materials: 8-inch (200-mm) Sample of each base material, character (letter, number, and graphic element) in each exposed color and finish not included in Samples above.
3. Exposed Accessories: Full-size Sample of each accessory type.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for signs.
1. Comply with the requirements of the Texas Accessibility Standards (TAS) as administered by the Texas Department of Licensing and Regulation (TDLR).
2. Braille: Provide Grade 2 Braille.
3. Font Height and Stroke Widths: Comply with applicable regulations.

B. Signage Type Requirements: Provide the minimum signage required by the applicable Building Code and the Fire Code, including, but not limited to, the following:

1. Building address identification.
2. Accessible path of travel, including parking, loading and walks.
3. Accessible toilet rooms.

C. Signage Sizes: As required to meet minimum requirements, and the following:

1. Provide signs of consistent size and proportion, large enough to convey necessary information.
   a. Room signs shall be nominal 6 inches by 6 inches.
   b. Signs shall be interchangeable message signs to extent feasible. Provide signs with fixed numbers and Braille, with two interchangeable message strips to accommodate present and future uses.
   c. For rooms with an obvious permanent function that cannot be re-purposed, provide interchangeable message sign with only one message slot, for sign size of approximately 6 inches wide by 5 inches high. Typical permanent-function rooms include electrical room, mechanical room, toilet room, etc.
   d. For special-purpose signs, provide signage consistent with room signage, meeting regulatory requirements.

D. Signage Layout:

1. The room number shall precede the room name or window insert.
2. The room number shall be consistent with the room designation in any energy management software, electrical panel directories, fire alarm system, etc.
3. Provide a unique room number for each space.
4. If a single space has multiple doors, all signage at doors shall reference the same room number.
5. Room numbers shall not exceed four digits.
   a. The first number of a room number shall be the floor level in multiple-story buildings.
   b. Numbers ending in "00" shall be reserved for corridors.
6. Generally number odd numbers on one side of a corridor with corresponding even numbers opposite.

2.2 SIGNS

A. Panel Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

1. Basis-of-Design Product: Nova Polymers; "Novacryl PT Series Photopolymer".
2. Laminated-Sheet Changeable Signs: Photopolymer face sheet with raised graphics and clear acrylic lens, both laminated over sub-surface graphics to backing sheet to produce composite sign panel with changeable message slots.
   
a. Basis of Design: Similar to Kroy Sign Systems, "Model Q28081" (without final backing plate), and as follows:
   
b. Photopolymer Tactile Header:
      
      1) Composition: 0.032 inch (0.8 mm) thick moisture resistant, non-glare interior nylon photopolymer on ultraviolet resistant clear PETG sign base, single piece construction. Total sheet thickness to match adjacent cast acrylic sheet, 0.125 inches (3.0 mm) nominal.
      
      2) Sustainable Certification: Minimum 40 percent pre-consumer recycled content.
      
      3) Laminated photopolymers, added-on or adhered characters, and engraved characters are not acceptable.
      
      
      5) Size: 3.5 inch by 5.5 inch.
      
   c. Acrylic Lens Messaging:
      
      1) 1/8 inch (3 mm) thick non-glare clear cast acrylic sheet.
      
      2) Subsurface graphic color to match photopolymer color.
      
      3) Size: 5.5 inch by 2.5 inch, with two 0.75 inch by 5.5 inch changeable insert slots. Insert slots shall be independent and shall accept 100-lb. cardstock.
      
      4) Graphic Application: By users, using laser-jet/ xerographic or ink-jet processes.
      
   d. Acrylic Back Plate:
      
      1) 1/8 inch (3 mm) thick acrylic sheet.
      
      2) Size: 6.0 inch by 6.0 inch. Back plate defines a 0.25-inch border with message plane.
      
      3) Surface-Applied Graphics: Paint or integral plastic color, continuous including edges.
      
   
f. Additional Subsurface Graphics: Reverse halftone or dot-screen image.


a. Edge Condition, Vertical and, Horizontal Edges: Square cut.

b. Corner Condition in Elevation: Square.

4. Mounting: Manufacturer's standard method for substrates indicated with countersunk flathead through fasteners.

5. Surface Finish and Applied Graphics:

a. Integral Acrylic Sheet Color: As selected by Architect from full range of industry colors.
6. Text and Typeface: Accessible raised characters and Braille. Finish raised characters to contrast with background color, and finish Braille to match background color.
   a. Design message inserts to accept 5/8 inch high sans serif font style, (Helvetica, Optima, Futura).

7. Flatness Tolerance: Sign panel shall remain flat or uniformly curved under installed conditions as indicated and within a tolerance of plus or minus 1/16 inch (1.5 mm) measured diagonally from corner to corner.

2.3 EXTERIOR PANEL-SIGN MATERIALS
A. Aluminum Sheet and Plate: ASTM B 209 (ASTM B 209M), minimum 0.080 inches (2 mm) thick, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

2.4 ACCESSORIES
A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signage, noncorrosive and compatible with each material joined, and complying with the following:
   1. Use concealed fasteners and anchors unless indicated to be exposed.
   2. For exterior exposure, furnish stainless-steel devices unless otherwise indicated.
   3. Sign Mounting Fasteners:
      a. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, installed in predrilled holes.

B. Adhesives: As recommended by sign manufacturer and that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.5 FABRICATION
A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
   1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
   2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
   3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
   4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
   5. Internally brace signs for stability and for securing fasteners.
6. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

B. Subsurface-Applied Graphics: Apply graphics to back face of clear face-sheet material to produce precisely formed image. Image shall be free of rough edges.

C. Shop- and Subsurface-Applied Vinyl: Align vinyl film in final position and apply to surface. Firmly press film from the middle outward to obtain good bond without blisters or fishmouths.

2.6 GENERAL FINISH REQUIREMENTS

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of signage work.

B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.

C. Verify that anchor inserts are correctly sized and located to accommodate signs.

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

3.2 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.

2. Install signs so they do not protrude or obstruct according to the accessibility standard.

3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.

B. Mounting Heights (Above Finished Floor): Comply with accessibility standards.

1. Room Identification Signage and Toilet Signage: Mount 5 feet 0 inches to center of sign.

C. Mounting Methods:
1. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.

3.3 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101423
SECTION 102113.19
PLASTIC TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
1. Solid-plastic toilet compartments
2. Solid-plastic toilet compartments custom-configured as stall entrance doors.
B. Related Requirements:
1. Section 055013 "Metal Fabrications" for connector requirements.

1.2 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 toilet compartments.
B. Shop Drawings: For toilet compartments.
1. Include plans, elevations, sections, details, and attachment details.
2. Show locations of centerlines of toilet fixtures.
3. Show locations of floor drains.
C. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:
1. Each type of material, color, and finish required for toilet compartments, prepared on 6-inch-(152-mm-)square Samples of same thickness and material indicated for Work.

1.3 INFORMATIONAL SUBMITTALS
A. Product Certificates: For each type of toilet compartment.

1.4 CLOSEOUT SUBMITTALS
A. Maintenance Data: For toilet compartments to include in maintenance manuals.
1.5 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 and source.

1. Latch and Keeper: Three latch(es) and keeper(s) with associated fasteners.
2. Fasteners: Twelve fasteners of each size and type.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 75 or less.
2. Smoke-Developed Index: 450 or less.

B. Fuel Contribution: Provide HDPE material passing the requirements of NFPA 286 “Standard Methods of Fire Test for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth”.

C. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board’s ADA-ABA Accessibility Guidelines for Buildings and Facilities and TAS for toilet compartments designated as accessible.

2.2 HIGH PRESSURE PLASTIC LAMINATE TOILET COMPARTMENTS (SP-1)

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

1. Ironwood Manufacturing (Basis of Design).
2. Bobrick Washroom Equipment, Inc.
3. Accurate Partitions Corporation.

B. Toilet Enclosure Style: Entrance doors and partitions

C. Door, Panel, and Pilaster Construction: High pressure plastic laminate 0.039 inch thick panel bonded under pressure with an adhesive to industrial-grade particle board. Door panels to have molding adhered to panel as shown in drawings. Panels not less than 1 inch (25 mm).

D. Brackets:
1. Manufacturer's standard design; stainless steel, Type 316 or 316L, as indicated.
2.3 HARDWARE AND ACCESSORIES FOR SP-1

A. Hardware and Accessories: Manufacturer's cast stainless steel in brushed silver finish operating hardware and accessories. Manufacturer's standard design.

1. Hinges: Surface mounted
2. Strike and Keeper: Wraparound style
3. Slide Latch: Surface Mounted
4. Coat Hook: Surface Mounted
5. Door Pull: Surface Mounted

2.4 SOLID-PLASTIC TOILET COMPARTMENTS (SP-2)

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

1. Accurate Partitions Corporation (Basis of Design).
2. Bobrick Washroom Equipment, Inc.

B. Toilet Enclosure Style: Entrance doors, as indicated.

C. Door, Panel, and Pilaster Construction: Solid, high-density polyethylene (HDPE) panel material, not less than 1 inch (25 mm) thick, seamless, with eased edges, and with homogenous color and pattern throughout thickness of material.

1. Adhesively weld door jamb constructions where greater than 1-inch thick.
2. Color and Pattern: One color and pattern in each room as indicated by manufacturer's designations.

D. Brackets (Fittings):

1. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel, Type 316 or 316L, as indicated.

2.5 HARDWARE AND ACCESSORIES FOR SP-2

A. Hardware and Accessories: Manufacturer's heavy-duty operating hardware and accessories.

1. Hinges: Minimum 0.062-inch-(1.59-mm-)thick Type 316 stainless-steel continuous. Mount as indicated.

   a. Basis of Design: Guden continous hinge, Model TS-06070409, 1.25 inch leaves, 0.125 inch hinge pin, 2.5 inch total width, for surface mounting.

2. Latch and Keeper: Heavy-duty surface-mounted cast-stainless-steel latch unit designed to resist damage due to slamming. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible. Mount with Type 316 stainless steel through-bolts (sex bolts or barrel bolts).
a. Basis of Design: Secure Line, Type 316 stainless steel barrel bolt, 3.5 inches, The Home Depot Model # 7655, Internet #205320393, Store SKU #1000055237.


4. Door Pull: Manufacturer's heavy-duty cast-stainless-steel pull at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible. Mount with through-bolts.

B. Anchorages and Fasteners: All fasteners shall be Type 316 stainless steel with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless-steel items complying with requirements of Section 055000.

2.6 MATERIALS

A. Stainless-Steel Sheet: ASTM A 666, Type 316/316L, stretcher-leveled standard of flatness.

B. Stainless-Steel Castings: ASTM A 743/A 743M.

C. Adhesive for High-Density Polyethylene Plastic: Provide the following two-component adhesive especially formulated for bonding low surface energy plastics such as polypropylene (PP), polyethylene (PE), and other thermoplastics commonly known as polyolefins, or accepted equal:

1. SCI Grip Americas, "PPX5".

2.7 FABRICATION

A. Fabrication, General: Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.

1. Adhesively weld door jamb constructions where greater than 1-inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.

1. Confirm location and adequacy of blocking and supports required for installation.
2. Fabricate to field-measured face of installed finishes.

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

A. General: Comply with manufacturer’s written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

1. Full-Height (Continuous) Jambs: Secure jambs to walls as indicated.

3.3 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer’s written instructions for proper operation.

END OF SECTION 102113.19
SECTION 105200
FIRE-PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Portable fire extinguishers.
2. Fire-protection cabinets for the following:
   a. Portable fire extinguishers.

B. Related Sections include the following:

1. Division 10 Section 101423 "Panel Signage" for directional signage to out-of-sight fire extinguishers and cabinets.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire-protection cabinets.

1. Fire Extinguishers: Include rating and classification.
2. Fire-Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.
3. Show location of knockouts for hose valves.

B. Samples for Initial Selection: For fire-protection cabinets with factory-applied color finishes.

C. Maintenance Data: For fire extinguishers and fire-protection cabinets to include in maintenance manuals.
1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fire extinguishers and fire-protection cabinets through one source from a single manufacturer.

B. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

C. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

D. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements of ASTM E 814 for fire-resistance rating of walls where they are installed.

1.5 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

1.6 WARRANTY

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

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

   a. Failure of hydrostatic test according to NFPA 10.
   b. Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

B. Clear Float Glass: ASTM C 1036, Type I, Class 1, Quality q3, 3 mm thick.

2.3 PORTABLE FIRE EXTINGUISHERS

A. Available Manufacturers:

1. Amerex Corporation.
2. Ansul Incorporated.
5. Fire End & Croker Corporation.
7. JL Industries, Inc.
8. Kidde Fyrmatics.
10. Modern Metal Products; Div. of Technico.
12. Potter Roemer; Div. of Smith Industries, Inc.
13. Watrous; Div. of American Specialties, Inc.

B. General: Provide fire extinguishers of type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.

1. Valves: Manufacturer's standard.
3. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

C. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:60-B:C, 10-lb (4.5-kg) nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.4 FIRE-PROTECTION CABINET

A. Available Manufacturers:

1. Fire End & Croker Corporation.
3. JL Industries, Inc.
5. Larsen's Manufacturing Company.
6. Modern Metal Products; Div. of Technico.
7. Moon American.
8. Potter Roemer; Div. of Smith Industries, Inc.
9. Watrous; Div. of American Specialties, Inc.

B. Cabinet Type: Suitable for fire extinguisher typical, and extinguisher and hose valve where required.

C. Cabinet Construction: Nonrated, typical and fire rated where required by code and design.

D. Cabinet Material: Enameled-steel sheet.

E. Recessed Cabinet: Cabinet box recessed in walls of sufficient depth to suit style of trim indicated.
   1. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend) of 1/4 to 5/16 inch (6 to 8 mm).

F. Cabinet Trim Material: Stainless steel sheet.

G. Door Material: Stainless steel sheet.

H. Door Style: Fully glazed panel with frame.

I. Door Glazing: Clear float glass.

J. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
   1. Provide recessed door pull and friction latch.
   2. Provide concealed hinge permitting door to open 180 degrees.

K. Accessories:
   1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
   2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
      a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER"
         1) Location: Applied to cabinet door.
         3) Lettering Color: Red or White; contrasting with background color.
         4) Orientation: Vertical.
   3. Alarm: Manufacturer's standard alarm that actuates when fire-protection cabinet door is opened and that is powered by batteries.
L. Finishes:

1. Manufacturer's Stainless steel for the following:
   a. Exterior of cabinet, door, and trim, except for those surfaces indicated to receive another finish.
   b. Interior of cabinet and door.

2.5 MOUNTING BRACKETS

A. Available Manufacturers:

1. Amerex Corporation.
2. Ansul Incorporated.
5. Fire End & Croker Corporation.
7. JL Industries, Inc.
9. Potter Roemer; Div. of Smith Industries, Inc.

B. Mounting Brackets: Manufacturer’s standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.


C. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

2.6 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub), with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

1. Weld joints and grind smooth.
2. Construct fire-rated cabinets with double walls fabricated from 0.0428-inch- (1.1-mm-) thick, cold-rolled steel sheet lined with minimum 5/8-inch- (16-mm-) thick, fire-barrier material.
   a. Provide factory-drilled mounting holes.
B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.

   1. Miter and weld perimeter door frames.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.7 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire-protection cabinets after assembly.

D. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 STEEL FINISHES

A. Surface Preparation: Clean surfaces of dirt, oil, grease, mill scale, rust, and other contaminants that could impair paint bond using manufacturer's standard methods.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for hose valves and cabinets to verify actual locations of piping connections before cabinet installation.

B. Examine walls and partitions for suitable framing depth and blocking where recessed and semirecessed cabinets will be installed.

C. Examine fire extinguishers for proper charging and tagging.

   1. Remove and replace damaged, defective, or undercharged units.

D. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION

A. Prepare recesses for recessed and semirecessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

A. General: Install fire-protection specialties in locations and at mounting heights indicated but confirm height is acceptable to authorities having jurisdiction.

1. Fire-Protection Cabinets: 54 inches (1372 mm) above finished floor to top of cabinet.
2. Mounting Brackets: 54 inches (1372 mm) above finished floor to top of fire extinguisher.

B. Fire-Protection Cabinets: Fasten fire-protection cabinets to structure, square and plumb.

1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is not adequate for recessed cabinets, provide semirecessed fire-protection cabinets.
2. Provide inside latch.

3. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.

C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

D. Identification: Apply vinyl lettering at locations indicated.

3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire-protection specialties are installed, unless otherwise indicated in manufacturer’s written installation instructions.

B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet manufacturer.
E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 105200
SECTION 108010

TOILET AND BATH ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Public-use washroom accessories.
2. Warm-air dryers.
3. Childcare accessories.
4. Underlavatory guards.
5. Custodial accessories.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include the following:

1. Construction details and dimensions.
2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
3. Material and finish descriptions.
4. Features that will be included for Project.
5. Manufacturer's warranty.

B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated on Drawings.
2. Identify products using designations indicated on Drawings.

C. Maintenance Data: For toilet and bath accessories to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: For products listed together in the same articles in Part 2, provide products of same manufacturer unless otherwise approved by Architect.
100% Construction Documents – 03-15-2019

TPWD Cedar Hill State Park Flood Repairs
TPWD No. 128269
HZ No. R302179.02

TOILET AND BATH ACCESSORIES

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.

1.5 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.6 WARRANTY

A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Stainless Steel: ASTM A 666, Type 304, 0.0312-inch (0.8-mm) minimum nominal thickness, unless otherwise indicated.

B. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.0359-inch (0.9-mm) minimum nominal thickness.


D. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.

E. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).

F. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

A. Available Manufacturers: Subject to compliance with requirements, preference should be given to manufacturers offering products with sustainable components contributing to LEED certification, manufacturers offering products that may be incorporated into the Work include, but are not limited to, as indicated in the drawings.

B. TOILET PAPER JUMBO ROLL DISPENSER (12):
   1. Description: Roll-in-reserve dispenser with hinged front secured with tumbler lockset.
   4. Capacity: Designed for 5-inch- (127-mm-) diameter tissue rolls.

C. TOILET PAPER JUMBO ROLL DISPENSER (05):
   1. Description: Two-roll unit.
   3. Capacity: 10-inch- (254-mm) diameter rolls.
   5. Lockset: Tumbler type.

D. WASTE CHUTE (10):
   1. Description: Permanent circular waste chute for countertops.
   2. Mounting: Inside countertop hole
   3. Size: 7 inch- (254-mm) outside diameter.

E. PAPER TOWEL DISPENSER/WASTE RECEPTACLE (11):
   1. Description: Combination unit for dispensing C-fold or multifold towels, with removable waste receptacle.
      a. Designed for nominal 4-inch (100-mm) wall depth.
   3. Minimum Towel-Dispenser Capacity: 600 C-fold or 800 multifold paper towels.
   5. Material and Finish: Stainless steel, No. 4 finish (satin).
   7. Lockset: Tumbler type for towel-dispenser compartment.

F. DECK-MOUNTED SOAP DISPENSER (01):
   1. Description: Designed for dispensing soap in foam form.
   4. Lockset: Tumbler type.
   5. Refill Indicator: Window type.
G. GRAB BAR (07 AND 08):

1. Mounting: Flanges with concealed fasteners.
2. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
   a. Finish: Smooth, No. 4, satin finish.
4. Configuration and Length: Comply with ADA and TDS, for toilet compartments and showers.

H. SANITARY NAPKIN DISPOSAL (06):

1. Mounting: Surface mounted.
2. Door or Cover: Latched door

I. SANITARY NAPKIN DISPOSAL AT COMFORT STATION (13)

1. Mounting: Surface mounted.
2. Door or Cover: Self-closing disposal-opening cover and hinged face panel with tumbler lockset.

J. CHANNEL FRAMED GLASS MIRROR (02):

1. Frame: Stainless-steel channel.
   a. Corners: Mitered and mechanically interlocked.
   b. Mount bottom of mirrors low enough to avoid tilting.
   a. One-piece, galvanized steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
3. Size: As indicated on the drawings.

K. PAPER TOWEL WASTE RECEPTACLE (20):

1. Description: Recessed removable waste receptacle.
   a. Designed for nominal 4-inch (100-mm) wall depth.
5. Liner: Reusable, vinyl waste-receptacle liner.
2.3 WARM-AIR DRYERS

A. Available Manufacturers: Subject to compliance with requirements, preference should be given to manufacturers offering products with sustainable components contributing to LEED certification, manufacturers offering products that may be incorporated into the Work include, but are not limited to, as indicated on drawings.

B. WARM-AIR HAND DRYER (03):

   a. Operation Time: 30 seconds.
4. Electrical Requirements: 110-120 VAC, 11.4 A, 730-1250 W.

2.4 CHILDCARE ACCESSORIES

A. Available Manufacturers: Subject to compliance with requirements, preference should be given to manufacturers offering products with sustainable components contributing to LEED certification, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. American Specialties, Inc.
2. General Accessory Manufacturing Co. (GAMCO).
4. Safe-Strap Company, Inc.

B. BABY CHANGING STATION (04):

1. Description: Horizontal unit that opens by folding down from stored position and with child-protection strap.
   a. Engineered to support a minimum of 250-lb (113-kg) static load when opened.
2. Mounting: Surface mounted, with unit projecting not more than 4 inches (100 mm) from wall when closed.
5. Liner Dispenser: Built in.
TOILET AND BATH ACCESSORIES

2.5 UNDERLAVATORY GUARDS

A. Available Manufacturers: Subject to compliance with requirements, preference should be given to manufacturers offering products with sustainable components contributing to LEED certification, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Plumberex Specialty Products, Inc.
2. Truebro, Inc.

B. Underlavatory Guard:

1. Description: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping, and allow service access without removing coverings.

2.6 CUSTODIAL ACCESSORIES

A. Available Manufacturers: Subject to compliance with requirements, preference should be given to manufacturers offering products with sustainable components contributing to LEED certification, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. American Specialties, Inc.
2. Bobrick Washroom Equipment, Inc.

B. Utility Shelf:

1. Description: With exposed edges turned down not less than 1/2 inch (12.7 mm) and supported by two triangular brackets welded to shelf underside.
2. Size: 16 inches (406 mm) long by 6 inches (152 mm) deep.
3. Material and Finish: Not less than nominal 0.05-inch- (1.3-mm-) thick stainless steel, No. 4 finish (satin).
4. Locate adjacent to mop sink.

C. Mop and Broom Holder:

1. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
2. Length: 36 inches (914 mm).
5. Material and Finish: Stainless steel, No. 4 finish (satin).

   a. Shelf: Not less than nominal 0.05-inch- (1.3-mm-) thick stainless steel.
   b. Rod: Approximately 1/4-inch- (6-mm-) diameter stainless steel.
6. Locate adjacent to mop sink

2.7 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

B. Grab Bars: Install to withstand a downward load of at least 250 lbf (1112 N), when tested according to method in ASTM F 446.

3.2 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

B. Remove temporary labels and protective coatings.

C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

END OF SECTION 108010
PART 1  GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Electrically operated, sunscreen and blackout roller shades. Include local, group and master motor control systems for shade operation with addressable, encoded, electronic drive units (EDU) including the following:
   1. Wireless daylight sensors (WDS).
   2. Wireless controllers (MWC).
   4. Turn-Key Single-Source Responsibility for Motorized Interior Roller Shades: To control the responsibility for performance of motorized roller shade systems, assign the design, engineering, and installation of motorized roller shade systems, motors, controls, and low voltage electrical control wiring specified in this Section to a single manufacturer and their authorized installer/dealer. Refer to additional requirements specified in this Section.

1.3 RELATED SECTIONS

A. Section 061000 - Rough Carpentry.
B. Section 092600 – Gypsum Board Assemblies.
C. Division 26 - Electrical: Electric service for motors, motor controls, internal communication, low voltage wiring and data transfer, and connection to Internet.

1.4 REFERENCES

B. NFPA 70 - National Electrical Code.
C. NFPA 701 - Fire Tests for Flame-Resistant Textiles and Films.
D. UL 325 - ANSI/CAN/UL Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems.

1.5 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Styles, material descriptions, dimensions of individual components, profiles, features, finishes and operating instructions.
   3. Storage and handling requirements and recommendations.
   4. Mounting details and installation methods.
5. Typical wiring diagrams including integration of EDU controllers with building management system, audiovisual and lighting control systems as applicable.

B. Shop Drawings: Plans, elevations, sections, product details, installation details, operational clearances, wiring diagrams and relationship to adjacent work.
   1. Include one-line diagrams, wire counts, coverage patterns, and physical dimensions of each item.
   2. Provide location plan showing all switch and control zones as per the performance requirements of the specifications. All switches, sensors and other control accessories must clearly be shown and called out in a bill of materials.

C. Window Treatment Schedule: For all roller shades. Use same room designations as indicated on the Drawings and include opening sizes and key to typical mounting details.

D. Selection Samples: For each finish product specified, one set of shade cloth options and aluminum finish color samples representing manufacturer’s full range of available colors and patterns.

E. Verification Samples: For each finish product specified, one complete set of shade components, unassembled, demonstrating compliance with specified requirements. Shadecloth sample and aluminum finish sample as selected. Mark face of material to indicate interior faces.

F. Maintenance Data: Methods for maintaining roller shades, precautions regarding cleaning materials and methods, instructions for operating hardware and controls.

G. Warranty: Provide manufacturer’s warranty documents as specified in this Section.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Obtain roller shades system through one source from a single manufacturer with a minimum of ten years experience and minimum of five projects of similar scope and size in manufacturing products comparable to those specified in this section.

B. Installer for Roller Shade System - Qualifications: Installer trained and certified by the manufacturer with a minimum of ten years experience in installing products comparable to those specified in this section.

C. Fire-Test-Response Characteristics: Passes NFPA 701 small and large-scale vertical burn. Materials tested shall be identical to products proposed for use.

D. Electrical Components: NFPA Article 100 listed and labeled by either UL or ETL or other testing agency acceptable to authorities having jurisdiction, marked for intended use, and tested as a system. Individual testing of components will not be acceptable in lieu of system testing.

E. Requirements for Electronic Hardware, Controls, and Switches: Roller shade hardware, shade fabric, EDU, and all related controls shall be furnished and installed as a complete two-way communicating system and assembly.

F. Requirements for Roller Shade Installer/Contractor:
   1. Roller Shade Hardware, shade fabric, motor, and all related controls shall be furnished and installed as a complete two-way communicating system and assembly.
   2. Roller Shade Installer/Contractor shall list all components and systems included in their bid, including but not limited to, the prime manufacturer of the motor control and automated equipment and shall be financially responsible for any change orders and/or
back charges required by the BMS, AV, or Lighting Control Systems contractors to interface with the automatic solar tracking system and the motorized roller shade system.

G. Mock-Up: Provide a mock-up of one roller shade assembly for evaluation of mounting, appearance and accessories.
   1. Locate mock-up in window designated by Architect.
   2. Do not proceed with remaining work until, mock-up is accepted by Architect.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver shades in factory-labeled packages, marked with manufacturer and product name, fire-test-response characteristics, and location of installation using same room designations indicated on Drawings and in the Window Treatment Schedule.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Install roller shades after finish work including painting is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Power and control wiring shall be complete and certified, fully operational with uninterrupted communication on the lines and minimal noise certified by a commissioning agent specified in other sections.

  1. 485, ICON, Lonmark and Dry Contract Network: Noise on the line not to exceed shade manufacturer's limits.

1.9 WARRANTY

A. Roller Shade Hardware and Chain Warranty: Manufacturer's standard non-depreciating twenty-five year limited warranty.

B. Standard Shadecloth: Manufacturer's standard twenty-five year warranty.

C. Roller Shade Motors and Motor Control Systems: Manufacturer's standard non-depreciating five year warranty.

D. Roller Shade Installation: One year from date of Substantial Completion, not including scaffolding, lifts or other means to reach inaccessible areas, which are deemed owners responsibility.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: MechoShade Systems, Inc.

2.2 ROLLER SHADE TYPES

A. Roller Shade Schedule: Refer to the Drawings for locations.
   1. Shade Type WT-4: Motorized interior room darkening blackout roller shades in all exterior / interior windows of rooms and spaces as shown on referenced Drawings, and related EDU control requirements systems. Include the following as scheduled and as indicated on the Drawings:
      a. Shade pockets.
      b. Fascias.
2.3 SHADECLOTH

A. Midnite 0200, Blackout Shadecloth with Opaque Acrylic Backing. PVC-Free, white color reverse side (for exterior). Comprised of 27 percent polyester yarn, 73 percent acrylic backing:
   1. Color: Selected from manufacturer's standard colors.
   2. Color: ICE 0202.

2.4 SHADE BANDS

A. Shade Bands: Construction of shade band includes the fabric, the enclosed hem weight, shade roller tube, and the attachment of the shade band to the roller tube. Sewn hems and open hem pockets shall not be acceptable.
   1. Concealed Hembar: Shall be continuous extruded aluminum for entire width of shade band and with the following characteristics:
      a. Hembar shall be heat sealed on all sides.
      b. Open ends shall not be accepted.
   2. Shade band and Shade Roller Attachment:
      a. Use extruded aluminum shade roller tube of a diameter and wall thickness required to support shade fabric without excessive deflection.
      b. Provide for positive mechanical attachment of shade band to roller tube; shade band shall be made removable / replaceable with a "snap-on" "snap-off" Spline mounting, without having to remove shade roller from shade brackets or insert shadeband from the side.
      c. Mounting Spline shall not require use of adhesives, adhesive tapes, staples, and/or rivets.
      d. Any method of attaching shade band to roller tube that requires the use of: adhesive, adhesive tapes, staples, and/or rivets, does not meet the performance requirements of this specification and shall not be accepted.

2.5 ROLLER SHADE COMPONENTS AND REQUIREMENTS

A. Access and Material Requirements:
   1. Provide shade hardware allowing for the removal of shade roller tube from brackets without removing hardware from opening and without requiring end or center supports to be removed.
   2. Provide shade hardware that allows for removal and re-mounting of the shade bands without having to remove the shade tube, drive or operating support brackets.

B. Motorized Shade Hardware and Shade Brackets:
   1. Provide shade hardware constructed of minimum 12 ga., 0.105 in. (2.67 mm) thick plated steel, or heavier, as required to support 200 percent of the motor stall torque Plastic components without use of steel angle construction do not meet the intent of this specification and shall not be accepted.
   2. Provide shade hardware system that allows for field adjustment of EDU or replacement of any operable hardware component without requiring removal of brackets, regardless of mounting position (inside, or outside mount).
   3. Provide shade hardware system that allows for operation of multiple shade bands offset by a maximum of 16-45 degrees from the EDU axis between shade bands (8-22.5 degrees) on each side of the radial line, by a single shade EDU (multi-banded shade, subject to manufacturer's design criteria).
   4. All bands within a single EDU group shall be aligned within 1/4 inch (6 mm).
C. Drive Bracket / Brake Assembly:
   1. MechoShade Drive Bracket model M5 shall be fully integrated with all MechoShade accessories, including, but not limited to: SnapLoc fascia, room darkening side / sill channels, center supports and connectors for multi-banded shades.
   2. M5 drive sprocket and brake assembly shall rotate and be supported on a welded 5/16-inch (7.96 mm) steel pin.
   3. The brake shall be an over-running wrapped spring clutch design which disengages during the raising and lowering of a shade. The brake shall withstand a minimum pull force of 50 lbs. (22 kg) in the stopped position.
   4. The braking mechanism shall employ an oil-impregnated hub on to which the brake system is mounted. The oil impregnated hub design includes a wrapped spring clutch assembly that ensures a smooth, non-jerky operation in raising and lowering the shades. The assembly shall be permanently lubricated requiring no maintenance. Products that require externally applied lubrication and/or are not permanently lubricated are not acceptable.
   5. The entire M5 assembly shall be fully mounted on the steel support bracket, and fully independent of the shade tube assembly, which may be removed and reinstalled without effecting the roller shade limit adjustments.

D. Drive Chain: #10 qualified stainless steel chain rated to 100 lb. (45 kg) minimum breaking strength. Nickel plate chain shall not be acceptable.

2.6 INTELLIGENT ENCODED ELECTRONIC DRIVE SYSTEM (120VAC)

A. Electronic Drive Unit (EDU):
   1. Intelligent Encoded EDU, and Control System: Tubular, asynchronous (non-synchronous) EDU's, with built-in ac motor and reversible capacitor operating at 120VAC/60Hz, (230VAC/50Hz) single phase, temperature Class B, thermally-protected, totally enclosed, maintenance-free and powered by a line voltage power supply connection equipped with locking disconnect plug assembly furnished with each EDU.
   2. Quiet [38 dB] (within 3 feet open air) depending on motor torque.
   3. EDU concealed inside shade roller tube.
   4. Maximum current draw for each shade EDU of 0.9Amps at 120VAC for IQ2 6nm; other current draw as applicable if other motors sizes required.
   5. Use EDU's rated at the same nominal speed for all shades in the same room.
   6. Use EDU's with minimum of 34RPM, that shall not vary due to load / lift capacity.
   7. Total hanging weight of shade band shall not exceed 80 percent of the rated lifting capacity of the shade EDU and tube assembly.
   8. UL325 Listed solution. UL Recognized solutions without the listing certification shall be unacceptable.
   9. UL or ETL listed marking shall be applied on a hang tag off the motor lead so that the inspector can readily verify the certification and rating of the motor. Products that require the shade assembly to be dismounted or partially dismounted for the motor or EDU to be removed from the shade roller tube for inspection shall be unacceptable.
   10. EDU shall possess an isolated, low voltage power supply for powering external accessories connected to either the dry contact port or the network port. Products that force accessories to always be powered by a plugin or externally supplied power supply shall not be acceptable.
   11. Provide EDU with the ability to upgrade firmware inside the motor from anywhere on the network without touching the motor.

B. EDU System: (software, two-way communication): Specifications and design are based on the Intelligent EDU Control System, WhisperShadeIQ2® System) as manufactured by Mecho (formerly MechoSystems). EDU and control systems not in complete compliance with these
performance criteria shall not be accepted as equal systems. EDU shall support two methods of control:

1. Local Isolated Dry Contact Control Inputs: EDU shall be equipped with dry contact inputs to support economical motor control as well as integration to third party systems without adding any interface modules. The dry contact inputs shall support moving the EDU/shade to the upper and lower limits as well as to local switch preset positions. They shall also support configuring the EDU under protected sequences so that a typical user would not change the EDU's setup. At a minimum the configuration should include setting limits, setting custom presets and configuring key modes of operation without requiring a PC or other similar microprocessor-driven tool.

2. Network Control: EDU shall be equipped with a bi-directional network communication capability in order to support commanding the operation of large groups of shades over a common backbone. The network communication card shall be embedded into the tubular EDU assembly. Upper and lower stopping points (operating limits) of shade bands shall be programmed into EDU's using either a hand held removable program module / configurator or a local switch.

C. Alignment Positions: Each EDU shall support a minimum of 133 repeatable and precisely aligned shade positions (including limits and presets):

1. All shades on the same switch circuit or with the same network group address with the same opening height shall align at each limit or preset (intermediate stopping position) when traveling from any position, up or down.

2. Shades of differing heights shall have capability for custom, aligned intermediate stop positions when traveling from any position, up or down.

3. Alignment of standard shade bands mechanically aligned on the same EDU shall not exceed +/- 0.125 in. (3.175 mm) when commanded to the same alignment position.

4. Alignment of standard shades on adjacent EDU's shall not exceed +/- 0.25 in. (6.35 mm) when commanded to the same alignment position.

D. Local Switch Presets: A minimum of 3 customizable preset positions shall be accessible over the local dry contact control inputs and over the network connection:

1. Upon setting the limits for the shade EDU these preset positions shall automatically default to 25 percent, 50 percent and 57 percent (75 percent) of the shade travel.

2. These positions shall be capable of being customized to any position between and including the upper and lower limits of the shade. A removable program module / configurator or local switch shall be capable of customizing the position of these presets.

E. Network Presets: A minimum of 32 customizable preset positions (including the 3 local switch presets) shall be accessible via network commands:

1. Upon setting the limits for the shade EDU these preset positions shall automatically default to the lower limit unless customized elsewhere.

2. These positions shall be capable of being customized to any position between and including the upper and lower limits of the shade. A removable program module / configurator shall be capable of customizing the position of these presets.

F. Network Control:

1. The system shall have the capability of two-way digital communication with the EDU's over a common backbone.

2. Each EDU shall possess 8 addresses capable of being employed for various levels of group control. These addresses shall be configurable via a handheld configurator and/or a PC controller. A 9th unique address shall enable the EDU(s) to be independently controlled and configured over the network via a handheld configurator and/or a PC controller.

G. Low Voltage Communication Network Implementation:
1. The low voltage network shall employ a bus topology with daisy chained network connections between nodes over a CAT5 cable (4 UTP) or over a 2 UTP cable employing at least 1 pair at 16 AWG for power and 1 pair at 22 AWG for data.

2. The low voltage network (+/- 13VDC) shall be powered by the nodes attached to it. These nodes could be line voltage powered EDU's attached to 120 VAC or 230 VAC. Alternatively, low voltage nodes shall be powered typically by a centralized low voltage power supply. If a CAT5 network cable is employed and the node draws less than 1W then the node may be powered by DC power supplied by an associated line voltage EDU.

H. Network Capacity: 4000 ft max, 250 nodes maximum. The number and size of a centralized DC supply shall vary depending upon the network requirements.

I. Uniform or Normal Modes of Operation: Uniform mode shall allow for shades to only move to defined intermediate stop positions to maintain maximum uniformity and organization. Normal Mode shall allow for shades to move to both intermediate stop positions, plus any position desired between the upper and lower limits as set by the installer.

2.7 WIRELESS CONTROLLERS

A. MechoNet Wireless Controllers (MWC):
1. EnOcean to MechoNet gateway, router and controller.
2. Designed to communicate via 902MHz RF (868MHz RF) with ultra-low power and solar-powered EnOcean devices providing wireless control and automation to window coverings over MechoNet.
3. Each MWC manages communication with up to 16 different EnOcean devices or channels.
4. Each controller can be configured to support one of two modes of operation:
   a. SolarTrac (ST) Mode: Relays EnOcean sensor and control information to the SolarTrac whole-building window management automation system.
   b. Solar Activated Control (SAC) Mode: Utilizes the EnOcean sensor and control information in order to feed internal automation algorithms for MechoNet window management control.
5. Powered by a dedicated low voltage 24VDC power supply or through MechoNet devices such as the IQ2 Motor or the IQ/MLC2 without adding extra power supplies.
6. Interacts with EnOcean standard Equipment Profiles as follows:
   c. Wireless Switches (EEP F6-02-02, A5-07-01, A5-07-02, A5-07-03).
7. Internal circular data buffer maintains a rolling 48-hour data log for every sensor commissioned to the MWC in order to support data transfer in case of power or communications loss.
8. Heartbeat communication routine with battery and solar-powered sensors in order to support troubleshooting and maintenance.
9. Toolless sensor pairing to the MWC with any device in paragraph 2.9.1.6.
10. Toolless RF level and sensor level testing to ensure curtainwall brightness sensors and occupancy sensors are located in places where they can reliably communicate with the MWC and provide good data.
11. SAC Mode automation algorithms for curtainwall brightness sensors support:
   a. Daylight automation positions window coverings for optimal visual comfort based on daylight levels using up to 5 positions: full-up, full-down, and up to 3 configurable presets. (The default setting enables full-up, full-down and preset 2).
   b. Customizable thresholds for each position are customizable including a common hysteresis setting (default: 20 percent) applied to all positions in order to prevent
frequent cycling of shades as daylight conditions fluctuate.

c. Customizable delay timers also help prevent frequent shade cycling. Window coverings will only change positions if the light level is above or below a threshold for a configurable minimum timeframe. Default settings are established to be more responsive to protect against increasing light levels. Up Timer, 300 seconds; Down Timer 60 seconds.

d. Night mode provides a configurable position for the window coverings at night to support LEED light pollution requirements, privacy requirements and/or energy conservation requirements. Configurable threshold determines when night mode begins and ends based on daylight level (defaults to 200 lux) and duration (defaults to 60 minutes to enter night mode, and 30 minutes to exit).

e. Occupancy/Vacancy: (optional). While occupied: window coverings are positioned based on daylight automation settings to optimize for comfort. While unoccupied/vacant: window coverings default to a configurable position (default: Full-down) to optimize for energy conservation.

f. Automation Override: Local switch overrides suspend daylight automation for the positioned window covering for a configurable timeframe (default: 60 minutes). When the timer expires, the window covering returns automatically to the last commanded daylight automation position.

g. Retract Mode manages changes to light level based on shade position for comfort and increasing exposure of the occupant to daylight. Window coverings move up in stepped one-position increments while daylight levels drop. Each step lasts for 1 minute while the controller retests the daylight condition before authorizing the next step until the target is reached.

12. Multiple sensors (channels) can be configured to automate the same window covering control zone in order to ensure operation based on worst case comfort conditions across the zone. The window covering will be positioned based on the daylight level from the highest sensor reading.

13. The data from each sensor can also be configured to automate multiple control zones.

2.8 WALL SWITCHES

A. Wired Wall Switches: Shades shall be operated by 2, 4, 5, 7, or 10-button low voltage standard switches. Standard switch shall be wired to a network interface and be programmed to transmit an address for the local switch. An address that is transmitted by either a switch or central controller shall be responded to by those EDU's with the same address in their control table. Standard switch may control an individual, sub-group or group of EDU's in accordance with the address in each EDU.

B. Wireless Wall Switches: Shades shall be operated by 2-button wireless standard switches in conjunction with MWC will be programmed to wireless transmit via 902MHz RF an address for the local switch. An address that is transmitted by either a switch or central controller shall be responded to by those EDU's with the same address in their control table. Standard switch may control an individual, sub-group or group of EDU's in accordance with the address in each EDU.

2.9 MECHONET NETWORK INTERFACE (MNI)

A. MechoNet Network Interface (MNI): shall provide for 3rd party integration to allow RS232/485 and dry contact inputs and dry contact outputs to support other motor and control systems.

1. Low voltage controller expands window covering control over MechoNet.
2. Four optically-isolated, low voltage Motor / Electronic Drive Unit (EDU) ports control shades, blinds and draperies.
3. Each Motor Port is configurable to support:
   a. WhisperShade IQ roller shades and blinds
MOTORIZED ROLLER SHADES

b. Somfy ILT2, FTS, DCT or RTS roller shades and blinds.
c. WhisperTrac 1000 or 3000 series drapery tracks.
d. Somfy GlydeaTM DCT or RTS drapery tracks.

4. Two models (MNI-RJ, MNI-TB) simplify motor wiring options.
5. Configurable port personalities enable virtually any company's User Interface (UI) to operate window coverings.
6. Four optically-isolated Switch Ports expand dry contact control options to keypads, sensors and third party controls.
7. Each Switch Port and Motor Port supports up to 5 alignment points and 3 customizable presets.
8. Uniform Mode setting maintains an architect's design intent at all times.
9. One IR remote control port supports various wireless IR remotes.
10. One configurable Serial Port for two-way RS232 or RS485 communication facilitates third party integration.
11. Two MechoNet Ports facilitate cost effective daisy chain wiring over MechoNet.
12. MechoNeM expands group control options across up to 250 nodes over 4000 ft. of industry standard CAT-5 or CAT-6 cable.
13. Each Motor Port possesses nine (9) MechoNet group control addresses which enables flexible multilevel control options.
14. Flexible power options can eliminate the need for a dedicated 24VDC supply.
15. Five diagnostic LEDs aid in troubleshooting configuration and wiring issues.
16. Firmware and port configurations are upgradable from any point on the network without climbing a ladder!
17. Settings are stored in non-volatile memory with a minimum ten-year life which recalls settings even in case of power failure.
18. The MechoNet Network Interface is a listed solution to UL325 and CSA 22.2 No. 427-92.

19. Environmental Specifications:
   a. Temperature Operating: 32 to 131 degrees F (0 to 500 degrees C)
   b. Humidity Operating: < 90 percent relative humidity, non-condensing.

2.10 ACCESSORIES

A. Roller Shade Pocket: For recessed mounting in drywall ceilings as indicated on the Drawings.
   1. Provide either extruded aluminum and or formed steel shade pocket, sized to accommodate roller shades, with exposed extruded aluminum closure mount, and removable closure panel to provide access to shades.
   a. Provide 'Vented Pocket' such that there will be a minimum of four 1 inch (25.4 mm) diameter holes per foot allowing the solar gain to flow above the ceiling line.
   b. Provide 'Electro Pockets' with raceway where applicable.

B. Fascia:
   1. Continuous removable extruded aluminum fascia that attaches to shade mounting brackets without the use of adhesives, magnetic strips, or exposed fasteners.
   2. Fascia shall be able to be installed across two or more shade bands in one piece.
   3. Fascia shall fully conceal brackets, shade roller and fabric on the tube.
   4. Provide bracket / fascia end caps where mounting conditions expose outside of roller shade brackets.
   5. Fascia shall include a channel for application of flexible material (shlegel) to closing off any light leakage between the fascia and a window frame, mullion, ceiling and/or any other horizontal surface.
   6. Fascia shall attach directly to the roller shade bracket without the need to install additional mounting hardware. Exposed fasteners shall not be allowed.
   7. Fascia shall positively lock in a top-down installation method to help prevent accidental
Room Darkening Shadeloc Channel system: Provides for shade-bands that lock into side channels to eliminate light gaps for room darkening, superior impact resistance and lower maintenance costs.

1. Material: Extruded aluminum SnapLoc channel and mounting base with concealed fastening for face or side mount. Exposed fasteners are not acceptable. Channels shall accept one-piece exposed blackout hem bar with vinyl seal to assure side light control and sill light control.

2. Zipper guide: White or black plastic inserted to Shadeloc channel to smoothly guide fabric through its full up and full down travel. Furnish with rubber foam cushions to adjust for field conditions.

3. S/L shade brackets:
   a. Single brackets: 5 in. (125 mm) wide by 5 in. (127mm) deep x 1/8 in. (3mm) thick plated steel brackets for ceiling, face or side mounting for precise alignment of Shadeloc channel.
   b. Double brackets: 7½ in. (179 mm) wide by 7-1/4 in. (184 mm) deep x 1/8 in. (3mm) thick plated steel brackets for ceiling, face or side mounting for precise alignment of Shadeloc channel.

4. Fabric: Furnished with zipper welded to the full height on both sides of the fabric as selected by architect from manufacturer's approved fabric offering.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

C. Confirm that blocking for roller shades is installed plumb, level, and fitted to window mullion as per interior architect's design documents and in accordance with industry standard tolerances. The horizontal surface of the shade pocket shall not be out-of-level more than 0.0625 inches (1/16 inch) (1.6 mm) over 20 linear feet (6 m).

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 RESPONSIBILITIES FOR INSTALLATION

A. Install roller shades level, plumb, square, and true according to manufacturer's written instructions, and located so shade band is not closer than 2 inches (50 mm) to interior face of glass. Allow proper clearances for window operation hardware.

B. Turn-Key Single-Source Responsibility for Interior Roller Shades: To control the responsibility for performance of the electric roller shade system; assign the design, engineering, and installation of electronic drive roller shade control system, shades, addressable controls, communication interfaces, and any required sensors, switches and low voltage control wiring specified in this Section to the manufacturer of the shade and control system. The Architect will not produce a set of electrical drawings for the installation of control wiring for the electric roller shade control system.
C. General Contractor Responsibilities:
   1. Provide power panels and circuits of sufficient size to accommodate roller shade manufacturer's requirements, as indicated on the mechanical and electrical drawings and manufacturer's shop drawings.
   2. Coordinate with requirements of Installer for this section before inaccessible areas are constructed.
   3. Coordinate requirements of ALSCS before inaccessible areas are constructed.
   4. Provide conduit with pull wire in all areas, which might not be accessible to ALSCS due to building design, equipment location or schedule.
   5. Coordinate with the main building electrical Installer to provide duplex 120 VAC power receptacle in electric closet for floor/riser communication gateways.
   6. Verify that wiring conditions, which have been previously installed under other sections or at a previous time, are acceptable for product installation in accordance with manufacturer's instructions.
   7. Comply with manufacturer's product data, including shop drawings, technical bulletins, product catalog installation instructions, and product carton instructions for installation.
   8. Protect installed product and finished surfaces from damage during all phases of installation including preparation, testing, and cleanup.
   9. Be responsible for all other required electrical work including but not limited to roof penetrations, conduits, fireproofing, and similar items.
   10. Provide conduit with pull wire in all areas, which might not be accessible to Installer due to building design, equipment location or schedule.
   11. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

D. Installer Responsibilities:
   1. Furnish and install shade controllers, interfaces, splitters, coupler, sensors, switches, junction boxes, etc mounted in the ceiling in an accessible location. Locations for all visible devices to be coordinated with Architect.
   2. Inspect all material included in this contract prior to installation and notify manufacturer of unacceptable material prior to installation.

E. Line Voltage Wiring: Furnish and install power connection between shade control system and EDU, and shall be capable of providing single line voltage wire pull for each EDU.

F. Shade Power Wiring:
   1. Installer shall furnish and install line voltage cable from roller shade motor into line voltage side of control system.
   2. Installer shall furnish and install wiring from wire power junction box (provided by General Contractor) to each motor on the shade network.
   3. Installer shall furnish and install a disconnect plug at the end of the power wiring run to each EDU. The disconnect plug must mate with a matching disconnect plug on the motor cable. EDU cable disconnect plug must be prefabricated by the manufacturer to meet UL and ETL systems requirements.

G. Integration with Third Party Systems: General Contractor shall coordinate and provide for others to furnish, install or program any interfaces or wiring to integrate 3rd party systems to the roller shade control system as specified herein. Integration to shade control network can be accomplished locally through dry contact closures, or RS-232.

3.4 INSTALLATION OF ROLLER SHADES

A. Install roller shades level, plumb, square, and true in accordance with manufacturer's recommendations, approved submittals, and in proper relationship with adjacent construction.
   1. Provide an on-site project manager who will attend all related jobsite scheduling
meetings.

2. Supervise the roller shade installation, and setting of intermediate stops of all shades to assure the alignment of the shade bands within a single EDU group, which shall not exceed +/- 0.125 inches (3.175mm), and to assure the alignment between EDU groups, which shall not exceed +/- 0.25 inches (6.35mm).

3. Be responsible for field inspection on an area-by-area and floor-by-floor basis during construction to confirm proper mounting conditions per approved shop drawings.

4. Provide accurate field measurements to 0.0625 inches (1/16 inch)(1.6 mm) for custom shade fabrication on the roller shades manufacturers input forms.

B. Install shades such that the shade band is not closer than 2 inches (50 mm) to the interior face of the glass. Allow proper clearances for window operation hardware.

C. Adjust, align and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

D. Installer shall set upper, lower and up to 3 intermediate stop positions of all motorized shade bands, and assure alignment in accordance with the above requirements.

E. Test and certify the operation of all motorized shades and turn over each floor for preliminary acceptance.

F. Participate and cooperate with the electrical contractor, shade manufacturer and the commissioning agent to verify and certify the installation is in full conformance with the specifications and is fully operational. This work to occur during the commissioning stage and is in addition to preliminary acceptance required for each floor.

3.5 INSTALLATION OF CONTROL SYSTEMS

A. Install control systems in accordance with manufacturer's recommendations and approved submittals.

B. Participate and cooperate with the electrical contractor, shade manufacturer and the commissioning agent to verify and certify the installation is in full conformance with the specifications and is fully operational. This work to occur during the commissioning stage and is in addition to preliminary acceptance required for each floor.

3.6 TRAINING

A. Provide a minimum of 4 hours on-site training for Owner's personnel to adjust, operate and maintain roller shade systems.

3.7 CLEANING AND PROTECTION

A. Clean roller shade surfaces after installation, according to manufacturer's written instructions.

B. Protect installed products until completion of project.

C. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Quartz agglomerate surfacing countertops.
   2. Quartz agglomerate backsplashes.
   3. Quartz agglomerate end splashes.
   4. Quartz agglomerate apron fronts.
   5. Adhesives and sealants.

B. Related Requirements:
   1. Section 061000 "Rough Carpentry".
   2. Section 079200 "Joint Sealants".
   3. Section 224000 "Plumbing Fixtures and Trim" for sinks and plumbing fittings.

1.3 REFERENCES


H. ISO: International Organization of Standardization.
QUARTZ AGGLOMERATE COUNTERTOPS


K. SCAQMD Rule 1168: Adhesive and Sealant Applications.


1.4 ACTION SUBMITTALS

A. Product Data: For countertop materials.
   1. Submit data for each specified product. Include manufacturer's technical data sheets and published installation instructions.
   2. Submit Safety Data Sheets (SDS) for adhesives and sealants.

B. Shop Drawings: For countertops. Submit dimensioned shop drawings showing countertop layouts, joinery, edge conditions, terminations, substrate construction, cutouts, and holes.
   1. Show locations and details of joints.
   2. Show direction of directional pattern, if any.
   3. Show plumbing installation provisions.

C. Samples for Initial Selection: For each type of material exposed to view.

D. Samples for Verification: For the following products:
   1. Countertop material, 6 inches (150 mm) square.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

B. Test Reports: Submit certified test reports showing compliance with specified performance characteristics and physical properties.

C. Warranty: Submit specimen copy of specified warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For quartz agglomerate countertops to include in maintenance manuals. Submit manufacturer's published maintenance and care manual. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.
1.7 QUALITY ASSURANCE

A. Regulatory Requirements


   a. SCAQMD (South Coast Air Quality Management District) Rule 1168.

B. Manufacturing Facility Qualifications: Quartz surfacing materials produced in an ISO 9001 certified facility.

C. Fabricator Qualifications: Minimum of five years documented experience in fabricating quartz surfacing countertops similar in scope and complexity to this Project, using water-cooled cutting tools. Currently certified by the manufacturer as an acceptable fabricator.

D. Installer Qualifications: Minimum of five years documented installation experience for projects similar in scope and complexity to this Project, and currently certified by the manufacturer as an acceptable installer.

E. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.

   1. Build mockup of typical countertop as shown on Drawings.
   2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's recommendations for shipping and handling quartz surfacing materials to preclude breakage and damage. Brace quartz surfacing units as necessary during shipment, transporting in near-vertical position with finished face towards finished face. Do not allow finished surfaces to rub during shipping and handling.

B. Store materials protected from exposure to harmful weather conditions, at temperature and humidity conditions recommended by the manufacturer. Store quartz surfacing sheet materials on racks in near-vertical position to preclude damage. Store with finished face turned towards finished face. Prevent warpage and breakage.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify dimensions of countertops and openings by field measurements before countertop fabrication is complete. Show recorded measurements on shop drawings.

B. Adhesives: Acclimate adhesives to occupancy room temperatures with maximum temperature not to exceed 75 deg F (24 deg C).
1.10 COORDINATION

A. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.

B. Coordinate locations of utilities that will penetrate countertops or backsplashes.

1.11 WARRANTY

A. Manufacturer's Limited Warranty: Standard 10 Year Commercial and Residential Limited Warranty against defects in quartz surfacing sheet materials.

PART 2 - PRODUCTS

2.1 QUARTZ AGGLOMERATE COUNTERTOP MATERIALS

A. Quartz Agglomerate: Solid sheets consisting of up to 93 percent quartz aggregate combined with polyester resin binders and proprietary pigments that are fabricated using vacuum vibrocompaction technology.

1. Basis-of-Design Product: Subject to compliance with requirements, provide one of the following or comparable product:

   a. Cosentino USA.
   b. LG Hausys America, inc.
   c. Wilsonart Quartz

2. Composition: Up to 93 percent quartz aggregate combined with polyester resin binders and proprietary pigments that are fabricated into slabs using Bretonstone vacuum vibrocompaction technology.

3. Material Thickness: Product Type 063, 1.18 inch (3 cm), nominal.

4. Material Weight: 15 lb/sq.ft. (73.2 kg/sq. m) for 1.18 inch (3 cm) thick surfacing.

5. Countertop Dimensions: As indicated on Drawings

6. Conformance Standards:

   a. NSF/ANSI Standard 51.
   b. UL 2818:

      1) GREENGUARD, emission levels in UL 2818, Section 7.1 are applicable for furniture products.
      2) GREENGUARD Gold, emission levels in UL 2818, Section 7.2 are applicable for building materials, finishes, and furnishings.

7. Physical Characteristics:

   a. Flexural Strength: Greater than 4,500 psi (31.0 MPa); ASTM D 790.
   b. Flexural Strain: Less than 0.375 percent; ASTM D 790.
   c. Flexural Modulus: Greater than 3.75 MPsi; ASTM D 790.
QUARTZ AGGLOMERATE COUNTERTOPS

d. Stain resistance (24 Hour): No effect to moderate effect; NEMA LD-3.
e. Abrasion Resistance: Greater than 100 in. lbs.; ASTM C 501.
f. Density: Greater than 2.1 g/cu. m per ASTM C 97.
g. Compressive Strength (One Axis - Div.): Greater than 20,000 psi (138 MPa) per ASTM C 170.
h. Moisture Absorption: Less than 0.03 percent per ASTM C 97.
i. Surface Burning Characteristics: Class I and Class A per ASTM E 84.

8. Quartz Finish: Polished finish with Glossometer reading greater than 45.
9. Colors and Patterns: As indicated on Drawings.
10. Edge Detail: As indicated on Drawings.

2.2 COUNTERTOP FABRICATION

A. General: Fabricate components in shop, to greatest extent practicable, in sizes and shapes indicated according to approved shop drawings and Wilsonart Quartz Fabrication manual.

B. Joint Seams: Form joint seams between quartz surfacing components with specified seam adhesive. Completed joints inconspicuous in appearance and without voids. Provide joint reinforced if required by manufacturer for particular installation conditions.

C. Cutouts and Holes: Provide holes and cutouts for service fixtures and similar countertop-mounted items as indicated. Form cutouts to required template or pattern, with smooth, even curves and eased edges.

D. Countertops: 1.18-inch- (3-cm-) hick, quartz agglomerate with integral edge.

E. Backsplashes: 1.18-inch- (3-cm-) thick, quartz agglomerate.

F. End Splash: Matching backsplash.

G. Fabricate tops with shop-applied edges and backsplashes unless otherwise indicated. Comply with quartz agglomerate manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

1. Fabricate with loose backsplashes for field assembly.

H. Joints: Fabricate countertops without joints.

I. Joints: Fabricate countertops in sections for joining in field.

1. Joint Locations: Not within 18 inches (450 mm) of a sink or cooktop and not where a countertop section less than 36 inches (900 mm) long would result, unless unavoidable.

2.3 INSTALLATION MATERIALS

A. Joint Adhesive: Methacrylate-based adhesive for chemically bonding quartz surfacing seams. Color complementary to quartz surfacing sheet material. UL 2818 GREENGUARD Gold certified and complying with SCAQMD Rule 1168.

2. Adhesives shall have a VOC content of 70 g/L or less.

B. Elastomeric Sealant: Mildew-resistant silicone sealant for filling gaps between countertops and terminating substrates in wet environment applications. Complies with ASTM C920, Type S (single component), Grade NS (nonsag).

2. Color: Selected from sealant manufacturer's standard offerings and See Architectural drawings.

C. Construction Adhesive: Countertop manufacturers recommended silicone-based construction adhesive for backsplashes, end splashes, and other applications according to manufacturer's published fabrication instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to receive quartz agglomerate countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops. Substrates must be sound, flat, smooth, and free from dust or other surface contaminants.

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

3.2 COUNTERTOP INSTALLATION

A. Install quartz surfacing components plumb, level, and true according to approved shop drawings and manufacturer's published installation instructions. Use woodworking and specialized fabrication tools acceptable to the manufacturer.

1. Fasten quartz surfacing components to base cabinets or other supporting substrates with suitable adhesives acceptable to manufacturer.

B. Form joint seams with specified seam adhesive. Seams to be inconspicuous in completed work. Seams in locations shown on approved shop drawings and acceptable to manufacturer. Promptly remove excess adhesive.

1. Clamp or brace quartz surfaces in position until adhesive sets.

C. Fill gaps between countertop and terminating substrates with specified silicone sealant.

D. Install backsplashes and end splashes where indicated on Drawings. Adhere to countertops with specified construction adhesive.

E. Vanities: Secure front panels to solid substrate with specified construction adhesive.
3.3 REPAIRS

A. If permissible to Architect, minor surface marring for quartz surfacing components may be repaired according to manufacturer's published installation instructions.

B. Remove and replace quartz surfacing components that are damaged and cannot be satisfactorily repaired.

3.4 CLEANING AND PROTECTION

A. Clean quartz surfacing components according to manufacturer's published maintenance instructions.

B. Completely remove excess adhesives and sealants from finished surfaces.

C. Protect completed work from damage during remainder of construction period.
SECTION 124800
PLAYGROUND EQUIPMENT AND STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related sections include the following:
   1. Section 329000 Trees, Shrubs and Groundcovers for quarry blocks, flagstone for tunnel structure, boulders and play sand.

1.2 SUMMARY
A. This Section includes the following:
   1. Freestanding playground equipment and structures.
   2. Composite playground equipment and structures.
   3. Nature Play elements constructed on site using stone, wood, recycled plastic and RCP pipe.
   4. Poured in place rubber playground surfacing

1.3 DEFINITIONS
A. EPDM: Ethylene propylene diene monomer

B. Fall Height: According to ASTM F 1487, "the vertical distance between a designated play surface and the protective surfacing beneath it."

C. HDPE: High-density polyethylene.


E. LLDPE: Linear low-density polyethylene.

F. MDPE: Medium-density polyethylene.

G. Use Zone: According to ASTM F 1487, "the area beneath and immediately adjacent to a play structure that is designated for unrestricted circulation around the equipment and on whose surface it is predicted that a user would land when falling from or exiting the equipment."
1.4 SUBMITTALS

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

B. Shop Drawings: Show fabrication and installation details for playground equipment and structures.

C. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Extent of surface systems and use zones for equipment.
   2. Critical heights for playground surface, or fall heights for equipment.

D. Samples for Initial Selection: For each type of playground equipment and structure indicated.
   1. Manufacturer’s color charts.
   2. Include similar Samples of playground equipment and accessories involving color selection.

E. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
   1. Posts and Rails: Not less than 6 inches long.
   2. Platforms: Not less than 6 inches square.
   3. Molded Plastic: Not less than 3 inches square.

F. Product Certificates: For each type of playground equipment, signed by product manufacturer.

G. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.

H. Qualification Data: For installer & manufacturer.

I. Material Certificates: For the following items, signed by manufacturers:
   1. Shop finishes.
   2. Recycled plastic.

J. Field quality-control test reports.

K. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for playground equipment.

L. Maintenance Data: For playground equipment and finishes to include in maintenance manuals.

M. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: By manufacturer or an employer of workers trained and approved by the manufacturer.
B. Manufacturer Qualifications: A firm whose playground equipment components have been certified by IPEMA's third-party product certification service.

1. Provide playground equipment and play structure components bearing the IPEMA Certification Seal.
2. Provide the following playground equipment and play structure components bearing the IPEMA Certification Seal:
   a. Kompan
   b. Columbia Cascade (Timberform)

C. Testing Agency Qualifications: An independent agency qualified according to ANSI Z34.1 for testing indicated.

D. Safety Standards: Provide playground equipment complying with or exceeding requirements in the following:

1. ASTM F 1487.
2. CPSC No. 325.

E. Pre-installation Conference: Conduct conference at Project site.

1.6 WARRANTY

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

1. Failures include, but are not limited to, the following:
   a. Structural failures including footings, sub-grades, and structure.
   b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Basis-of-Design Product: The design for each piece of playground equipment is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

B. Steel: Comply or exceed with the following:
   1. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
   3. Steel Tubing: ASTM A 500 or ASTM A 513, cold formed.
   4. Steel Sheet: ASTM A 1011/A 1011M.
   5. Perforated Metal: Steel sheet not less than 0.0747-inch uncoated thickness; manufacturer's standard perforation pattern.
   6. Expanded Metal: ASTM F 1267, Type II (expanded and flattened), Class 1 carbon-steel sheets, deburred after expansion.

C. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666; Type 304.

D. Chain and Fittings: ASTM A 467/A 467M, Class CS, 4/0 or 5/0, welded-straight-link coil chain; hot-dip galvanized. With commercial-quality, hot-dip galvanized steel connectors and swing or ring hangars.

E. Castings and Hangers: Malleable iron, ASTM A 47/A 47M, Grade 32510, hot-dip galvanized.

F. Post Caps: Cast aluminum, UV-stabilized, mold-resistant polyethylene or polypropylene; color to match posts.

G. Platform Clamps and Hangers: Cast aluminum, not less than 0.105-inch nominal thickness.

H. Hardware: Manufacturer's standard; commercial-quality; corrosion-resistant; hot-dip galvanized steel and iron, stainless steel, or aluminum; of a secure and vandal-resistant design.

I. Fasteners: Manufacturer's standard; corrosion-resistant; hot-dip galvanized or plated steel and iron, or stainless steel; permanently capped, and theft resistant.

J. Recycled Plastic
   1. Planks for Sandbox edge: Planks shall be 2x12 recycled HDPE plastic with fiberglass strands for reinforcement. Color: Brown. Fiberforce by Bedford Technology (800) 721-9037 or approved equal.

K. Opaque Plastic: Color impregnated, UV stabilized, and mold resistant.
1. **Polyethylene**: Fabricated from 96 percent recycled, purified, fractional-melt plastic resin; rotationally molded HDPE, LLDPE, or MDPE with not less than 1/4-inch wall thickness.

L. **RCP PIPE**: Concrete pipe shall be standard 36" diameter x 72" length, complying with ASTM C 76 with smooth interior surface as approved by Rinker Materials 832) 590-5305 or approved equal. Pipe shall be standard gray concrete, free of chips, cracks or discoloration.

M. **Poured in Place Rubber Paving**: Poured-in-place EPDM rubber surfacing shall be composed of two layers poured in place with a upper wear course and cushion layer beneath. Contractor shall determine cushion depth relative to fall zone extents and height from surrounding play equipment. Base course and installation methods shall be per manufacturer specifications. Contractor shall supply Owner with samples of earhtone colors (Mid-gray, Brown, Beige and Eggshell) to contrast with surrounding boulders and limestone slabs.

2.3 **PLAYGROUND EQUIPMENT FABRICATION**

A. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

B. **Metal Frame**: Fabricate main-frame upright support posts from metal pipe or tubing with cross-section profile and dimensions as indicated. Form metal to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arcs.

1. Fabricate secondary frame members, bracing, and connections from either steel or aluminum. Unless otherwise indicated, provide each pipe or tubing main-frame member with manufacturer’s standard drainable bottom plate or support flange.

2. Form simple and compound curves in bars and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.

3. Cut, drill, and punch metals cleanly and accurately. Remove sharp or rough areas on exposed surfaces.

4. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to weather in a manner to exclude water.

5. Comply with AWS recommended practices for shop welding and brazing. Weld and braze behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed joints of flux, and dress exposed and contact surfaces.

6. Provide weep holes where water may accumulate.

C. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap to receive finish hardware, screws, and similar items, unless otherwise indicated.

D. Provide castings that are sound and free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.
E. Composite Frame: Fabricate main-frame upright support posts from metal and plastic with profile and dimensions as indicated. Fabricate secondary frame members, bracing, and connections from either steel or aluminum.

F. Play Surfaces: Provide manufacturer's standard elevated drainable decks, platforms, landings, walkways, ramps, and similar transitional play surfaces, designed to withstand loads; fabricated from perforated or expanded metal made into floor units with slip-slip-resistant foot surfaces. Fabricate units in manufacturer's standard modular sizes and shapes to form assembled play surfaces indicated.

G. Elevated Play Surfaces: Guardrails or protective barriers completely surround elevated play surface except for access openings, if play-surface heights above protective surfacing exceed the following for use by age group indicated:

1. Elevated surface greater than 20 inches intended for use by children aged 2 through 5.
2. Elevated surface greater than 30 inches intended for use by children aged 5 through 12.

H. Stepped Play Surfaces: Provide manufacturer's standard infill between stepped platforms according to referenced standards and where indicated on Drawings.

I. Protective Barriers and Guardrails: Fabricate according to ASTM F 1487 and as follows:

1. Welded metal pipe or tubing with vertical bars.
2. Steel sheet with openings for vision and ventilation.
3. Welded metal-pipe or -tubing frame with woven wire mesh infill panels.
4. Opaque, solid plastic panels with openings.
5. Vertical wood balusters with metal pipe or tubing or wood frame.

J. Handrails: Welded metal pipe or tubing, OD between 0.95 and 1.55 inches. Provide handrails at height for use by age group indicated below:

1. Ages: Between 2 and 5 years.
2. Height of Top Surface: 29 inches intended for use by children aged 2 through 5.
3. Close exposed ends of handrails with returns with clearance of 1/4 inch or less.

K. Signs: Manufacturer's standard sign panels, fabricated from opaque plastic with graphics molded in, attached to upright support posts.

1. Text: at manufacturer's discretion and as needed.
2. Colors: to match and TBD by owners

2.4 PLAYGROUND EQUIPMENT AND STRUCTURES BASIS OF DESIGN

A. KOMPAN – COR23601101 Large Climbing Net

1. Products:
   a. Kompan COR23601101

2. Net Color: Green

3. Manufacturer: Kompan
B. Columbia Cascade Custom Embankment Slide:

1. Products:
   a. Columbia Cascade, straight embankment slide, Model No. 1650-51-EMB
      Timberform entry platform.

2. Color:
   Slide: Tan, Metal Platform: Dark Brown

3. Manufacturer: Columbia Cascade
   1300 SW Sixth Avenue, Suite 310
   Portland, OR 7201-3464
   (800) 547-1940

C. Shade Systems Inc.

1. Products:
   a. Single Post Pyramid, 20’ x 20’

2. Fabric Color: Tan, Post Color: Dark Brown

3. Manufacturer: Shade Systems Inc
   4150 SW 19th St
   Ocala, FL 34474
   (800) 609-6066

2.5 CAST-IN-PLACE CONCRETE FOR FOOTINGS

A. Concrete Materials and Properties: Comply with requirements in Division 3 Section "Cast-in-Place Concrete" to produce normal-weight, concrete with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum-size aggregate.

B. Concrete Materials and Properties: Dry-packaged concrete mix complying with ASTM C 387 and mixed at site with potable water, according to manufacturer’s written instructions, to produce normal-weight concrete with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum-size aggregate.

2.6 FINISHES, GENERAL

A. Comply with NAAMM’s "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are
acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 ALUMINUM FINISHES

A. Baked-Enamel Finish: Prepare, treat, and coat metal to comply with paint manufacturer's written instructions and as follows:

1. Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness not less than 3 to 5 mils, medium gloss.

B. PVC Finish: Manufacturer's standard, UV-stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on, PVC-plastisol finish, with flame retardant added, complying with coating manufacturer's written instructions for pretreatment, application, and minimum dry film thickness of 80 mils.

C. Color: As selected by Owner from manufacturer's full range.

2.8 IRON AND STEEL FINISHES

A. Galvanizing: Hot-dip galvanize products made from rolled-, pressed-, and forged-steel shapes, castings, plates, bars, and strips indicated to be galvanized to comply with ASTM A 123/A 123M.

1. Hot-dip galvanize steel and iron hardware indicated to be galvanized to comply with ASTM A 153/A 153M.

2. Galvanized Steel Sheet: Commercial steel sheet, hot-dip galvanized, complying with ASTM A 653/A 653M for not less than G60 (Z180) coating designation; mill phosphatized.

B. Powder-Coat Finish: Prepare, treat, and coat ferrous metal to comply with resin manufacturer's written instructions and as follows:

1. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils.

C. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.

D. PVC Finish: Manufacturer's standard, UV-stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on, PVC-plastisol finish, with flame retardant added, complying with coating manufacturer's written instructions for pretreatment, application, and minimum dry film thickness of 80 mils.

E. Color: As selected by Owner from manufacturer's full range.
2.9 STAINLESS-STEEL FINISHES

A. Remove tool and die marks and stretch lines or blend into finish.

B. Bright, Cold-Rolled, Unpolished Finish: No. 2B finish on exposed faces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, site surface and sub grade drainage, and other conditions affecting performance.

1. Do not begin installation before final grading required for placing protective surfacing is completed, unless otherwise permitted by Owner.

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

3.2 PREPARATION

A. Verify locations of playground perimeter and pathways. Verify that playground layout and equipment locations comply with requirements for each type and component of equipment.

3.3 INSTALLATION, GENERAL

A. General: Comply with manufacturer’s written installation instructions, unless more stringent requirements are indicated. Anchor playground equipment securely, positioned at locations and elevations indicated.

1. Maximum Equipment Height: Coordinate installed heights of equipment and components with finished elevations of protective surfacing. Set equipment so fall heights and elevation requirements for age group use and accessibility are within required limits. Verify that playground equipment elevations comply with requirements for each type and component of equipment.

B. Post and Footing Excavation: Excavate holes for posts and footings as indicated in firm, undisturbed or compacted subgrade soil. Project Coordinator shall verify before concrete is poured.

C. Post Set on Sub grade: Level bearing surfaces with drainage fill to required elevation.

D. Post Set with Concrete Footing: Comply with ACI 301 for measuring, batching, mixing, transporting, forming, and placing concrete.

1. Set equipment posts in concrete footing per manufacturer requirements and guidelines. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at the correct angle, alignment, height, and spacing.
a. Place concrete around posts and vibrate or tamp for consolidation. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.

b. Project Coordinator will inspect and approved all concrete footings are per manufacturer requirements, full depth, and secured. No backfill, grading, or play surface shall be installed until concrete footings have been verified. Project Coordinator may assign this inspection to Landscape Architect and/or Product manufacturer and their representatives.

2. Embedded Items: Use setting drawings and manufacturer's written instructions to ensure correct installation of anchorages for equipment.

3. Concrete Footings: Smooth top, and shape to shed water.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: General Contractor shall engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. General Contractor shall arrange for playground equipment manufacturer's technical personnel to inspect playground and playground equipment and components during installation and at final completion and to certify compliance with the following:

1. ASTM F 1487.
2. CPSC No. 325.
3. Proper play system layout
4. Post excavation and depths
5. Concrete footings

END OF SECTION 124800
SECTION 129300
SITE FURNISHINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Related sections include the following:
   1. Section 329000 Trees, Shrubs and Groundcovers for limestone benches and flagstone slabs.

1.2 SUMMARY
A. Coordinate all products with TPWD prior to order and installation.

B. Section Includes:
   1. Single Picnic Table
   2. Single ADA Picnic Table
   3. Double Picnic Table
   4. Double ADA Picnic Table
   5. Triple ADA Picnic Table
   6. Standard Charcoal Grill
   7. ADA Accessible Charcoal Grill
   8. Large Group Charcoal Grill
   9. Hosebibs
   10. Bollards

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.

1.4 CLOSEOUT SUBMITTALS
A. Maintenance Data: For site furnishings to include in maintenance manuals.

PART 2 - PRODUCTS

1. SINGLE PICNIC TABLE (as proposed at select Picnic canopies)
   A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or comparable product as accepted by the ODR:
      Manufacturer: Pilot Rock
      Phone: (712) 225-5115 or (800) 762-5002
      Website address: www.pilotrock.com
SITE FURNISHINGS

2. SINGLE ADA PICNIC TABLE (as proposed at select Picnic canopies)

A. Style: Model # XT-6, Hot dipped galvanized, 6’ length seats and table. Mount to concrete pad per manufacturer’s specifications.

B. Style: Model # XT-6E, Hot dipped galvanized, 6’ length seats and 8’ table. Mount to concrete pad per manufacturer’s specifications.

3.. DOUBLE PICNIC TABLE (as proposed at select Picnic canopies)

A. Style: Model # XT-12, Hot dipped galvanized, 12’ length seats and table. Mount to concrete pad per manufacturer’s specifications.

B. Style: Model # XT-12, Hot dipped galvanized, 12’ length seats and table. Mount to concrete pad per manufacturer’s specifications.

4. DOUBLE ADA PICNIC TABLE (as proposed at select Picnic canopies)

A. Style: Model # XT-12, Hot dipped galvanized, 12’ length seats and table. Mount to concrete pad per manufacturer’s specifications.

5. TRIPLE ADA PICNIC TABLE (as proposed at select Picnic canopies)

A. Shall consist of one Single ADA picnic table (see 2.3 above) and one Double picnic table (see 2.4 above) pushed together and fastened to concrete pad.

6. STANDARD CHARCOAL GRILL (as proposed at select Picnic canopies)

A. Style: Model # XT-12, Hot dipped galvanized, 12’ length seats and table. Mount to concrete pad per manufacturer’s specifications.
Manufacturer: Pilot Rock  
Phone: (712) 225-5115 or (800) 762-5002  
Website address: www.pilotrock.com

B. Style: Model # J-20 B2, standard black enamel finish, 15” x 20” x 8”. Mounting style: Embedded post per manufacturers specifications.

7. ADA ACCESSIBLE CHARCOAL GRILL (as proposed at ADA Picnic canopies, and existing pavilion)

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or comparable product as accepted by the ODR:
   Manufacturer: Pilot Rock  
   Phone: (712) 225-5115 or (800) 762-5002  
   Website address: www.pilotrock.com

B. Style: Model # ASW-20, standard black enamel finish, 15” x 20” x 6”. Mounting style: Surface mount to concrete pad per manufacturer’s specifications.

8. LARGE GROUP CHARCOAL GRILL (as proposed at existing pavilion)

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or comparable product as accepted by the ODR:
   Manufacturer: Pilot Rock  
   Phone: (712) 225-5115 or (800) 762-5002  
   Website address: www.pilotrock.com

B. Style: Model # Q3-2460 B8, standard black enamel finish, 60” x 24” x 10”. Mounting style: Surface mount to concrete pad per manufacturer’s specifications.

9. HOSE BIB (as proposed along trail throughout Day Use Picnic Areas)

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or comparable product as accepted by the ODR:
   Haws Model 6252EHLF Faucet Valve  
   Haws 1455 Kleppe Lane  
   Sparks, NV 89431  
   (775) 359-4712

10. BOLLARDS (as proposed at Group Recreational Hall)

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or comparable product as accepted by the ODR:
B. Dumor Bollard 400-36 S-1 Embedded, 36” height above grade, 36” embedment in 42” concrete footing as specified by manufacturer, 4 ¼” O.D, SCH 40 Steel pipe, Color: “Sudan Brown” powder coated finish

Dumor
P.O. Box 1142
Mifflintown, PA 17059
800) 598-4018
sales@dumor.com

11. RECYCLED PLASTIC POST (as proposed at trailside hosebibs)

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or comparable product as accepted by the ODR:

5 ¼” x 5 ¼” x 5’ recycled plastic posts. Color: Brown, “Selectforce” lumber by Bedford Technology (800) 721-9037 or approved equal.

2.2 FABRICATION

A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.

B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.

C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.

D. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.

E. Factory Assembly: Assemble components in the factory to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

2.3 GENERAL FINISH REQUIREMENTS

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.

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

3.2 INSTALLATION, GENERAL

A. Comply with manufacturer’s written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.

B. Coordinate installation of cast-in-place site furnishings with landscaping and paving work.

C. Install site furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.

D. Post Setting: Set cast-in-place support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.

END OF SECTION 129300
SECTION 221000
PLUMBING PIPING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, Supplementary General Conditions, all applicable requirements of Division 1, “General Requirements”, and Section 230000, “Mechanical General Provisions”, govern this Section.

1.2 DESCRIPTION OF WORK:
A. Work Included: Provide complete operating plumbing piping systems including pipe, tube, fittings, and appurtenances as indicated and in compliance with these Specifications. The Work of this Section shall include, but not be limited to:
B. Securing and installing plumbing services for the building.
C. A complete domestic hot and cold water distribution system.
D. A complete sanitary soil waste and vent system.
E. Miscellaneous plumbing equipment and specialties required for a complete plumbing systems as specified.
F. Plumbing Services: Secure all plumbing services necessary for the project as required or shown on the Contract Drawings, including paying all required fees and charges. Work related to plumbing services maybe shown on Plumbing, Civil, Architectural or other drawings in the Contract Documents. Plumbing services include, but are not limited to:
1. Securing water connection permit from the authority having jurisdiction.
2. Extending water service from meter box to building entry.
3. Securing sanitary sewer connection permit from the authority having jurisdiction, if required.
4. Connecting or arranging for the connection of the sanitary lines(s) into the sanitary sewer in accordance with the authority having jurisdiction.
5. Installing all drainage systems with the proper slope as required by code.
6. Boring and jacking existing streets, sidewalks, etc., in city right-of-ways as is necessary. (Where this stipulation cannot be met, it shall be the responsibility of the plumbing contractor to secure all necessary permits at his cost to do whatever is required to secure the service from the city or local authority, and make whatever repairs necessary after the service is secured.)
G. The Division 23 and/or 22 Contractor shall be responsible for coordinating plumbing services and site utility work as shown on the Contract Drawings with the General Contractor to determine what work is included in the scope of the Division 23 and/or 22 Contractor.
H. Applications: Applications of piping systems include, but are not limited to, the systems as listed below:

<table>
<thead>
<tr>
<th>WORKING OPERATING</th>
<th>SYSTEM PRESSURE</th>
<th>TEMPERATURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Cold Water</td>
<td>Low 150 psig</td>
<td>55°F to 80°F</td>
</tr>
<tr>
<td>Domestic Hot Water</td>
<td>Low 150 psig</td>
<td>90°F to 120°F</td>
</tr>
</tbody>
</table>

I. Valves and Accessories: Refer to Section 22 10 31 for additional plumbing piping system components.

J. Insulation: Refer to Section 23, "System Insulation", for piping system insulation.

K. Texas Parks and Wildlife (TPWD) Uniform General Conditions (UGC): Contractor is responsible for following all requirements in the owners (TPWD) UGC. The stricter of these requirements or the owners UGC requirements shall be followed. Where UGC is in conflict with these specifications the contractor shall submit an RFI asking for direction from the Engineer. Where requirements are in the UGC but not in these specifications the UGC requirements shall be followed.

1.3 QUALITY ASSURANCE:

A. Welding: Qualify welding procedures, welders, and operators in accordance with ANSI B31.1, Paragraph 127.5, for shop and job site welding of piping work. Make welded joints on the piping system with continuous welds, without backing rings and with pipe ends beveled before welding. Gas cuts shall be true and free from burned metal. Before welding, surfaces shall be thoroughly cleaned. The piping shall be carefully aligned and no weld metal shall project inside the pipe. Refer to Section 23 00 00 for additional requirements.

B. UPC Listing: All materials, fixtures or devices used or entering into the construction of the plumbing system shall be listed for UPC or shall conform to Alternate Standards recognized as "equal" by the Officials having jurisdiction.

C. Cast Iron Pipe Testing: All cast iron waste and vent pipe shall be 100% factory water pressure tested.mittal.

D. Cast Iron Pipe Manufacturers: Cast iron pipe shall be as manufactured by Tyler Pipe or Charlotte Pipe and Foundry.

E. Installer Qualifications:

1. Company shall have minimum three years documented experience specializing in performing the work of this section.

2. Installation of plumbing systems shall be performed by individuals licensed by the Texas State Board of Plumbing Examiners as a Journeyman or Master Plumber. Installation may be performed by Apprentice Plumbers provided they are registered with the Texas State Board of Plumbing examiners and under direct supervision of a licensed plumber. All installation shall be supervised by a licensed Master Plumber.
3. All installers of copper press fittings shall be trained by the fitting manufacturer's appointed representative. Written notification of training shall be submitted to Owner prior to any installation.

1.4 SUBMITTALS:
A. Shop drawing submittals shall include, but not be limited to, the following:
   1. Cut sheets marked to clearly indicate all plumbing piping system materials.
   2. Piping fabrication drawings for all main piping runs including connections to existing piping. Fabrication drawings shall include plan views and suitable elevations and shall include all accessories and equipment.
   3. Additional items as required in Section 230000.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:
A. Deliver components in factory-fabricated water resistant packaging, as applicable.
B. Handle components carefully to avoid damages to components, enclosures, and finish.
C. Store components in a clean, dry space, and protect from weather.

PART 2 - PRODUCTS
2.1 PIPING MATERIALS:
A. General: Provide pipe and tube of type, joint, grade, size, and weight (wall thickness, schedule or class) indicated for each service. Comply with applicable governing regulations and industry standards.
B. Steel Pipe: ASTM A53 or ASTM A106 black or hot-dipped galvanized as specified. Piping shall be domestically manufactured by one of the manufacturers listed in the latest edition of the American Petroleum Institute (API) approved manufacturers listing.
C. Copper Tube: ASTM B88, Types "K", Type "L", or Type "M" copper water tube as defined by the Copper and Brass Research Association.
D. Cast Iron Pipe: ANSI C-150, Class 150 mechanical joint.
E. Cast Iron Soil Pipe: ASTM A74, ANSI A.112.5 service weight, hub and spigot-type, asphalt or coal tar pitch coated.
F. Hubless Cast Iron Soil Pipe: CISPI 301-82, service weight with spigot bead ends for coupling assembly, or asphalt or coal tar pitch coated.
G. Polyvinyl Chloride (PVC) Storm Pipe: Schedule 40 PVC with bell ends and pre-inserted gasket joints.
H. PEX-a: PEX-a(Engel-Method Crosslinked Polyethylene) Piping: ASTM F 876 and F877 by UPONOR. Connections are made using cold expansion method.

2.2 PIPE/TUBE FITTINGS:
A. General: Provide factory-fabricated fittings of type, materials, grade, class, and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve, and equipment connections. Where not otherwise indicated, comply with governing regulations, industry standards, and where applicable, with pipe manufacturer's
instructions for selections.

1. Cast Iron Flanged Fittings: ANSI B16.1, Class 125 or Class 250, black or galvanized as specified, including bolting and gasketing.

2. Cast Iron Threaded Fittings: ANSI B16.4 or ASTM A126, Class 125 or Class 250, black or galvanized as specified.

3. Malleable Iron Threaded Fittings: ANSI B16.3, Class 150 or Class 300, black or galvanized as specified.

4. Malleable Iron Threaded Unions: ANSI B16.39, select for proper piping fabrication and service requirements including style, end connections, and metal-to-metal seats (iron, bronze, or brass), plain or galvanized as specified.


6. Steel Flanges/Fittings: ANSI B16.5, including bolting, gasketing, and butt weld end connections.

7. Forged Steel Socket-welding and Threaded Fittings: ANSI B16.11, rated to match schedule of connected pipe.

8. Wrought Steel Butt-welding Fittings: ANSI B16.9, except ANSI B16.28 for short radius elbows and returns; rated to match connected pipe.


10. Pipe Nipples: Fabricated from same pipe as used for connected pipe, except do not use less than Schedule 80 pipe where length remaining unthreaded is less than 1/2”. Do not thread nipples full length (no all-thread nipples).


12. Grooved End Fittings: ASTM A47 or ASTM A536 joined with Victaulic Style 77 or Style 07 couplings and Grade “E” gaskets on steel systems.


14. Flange Bolts: Bolts shall be carbon steel ASTM A307 Grade A hexagon head bolts and hexagonal nuts. Where one or both flanges are cast iron, furnish Grade B bolts. Cap screws utilized with flanged butterfly valves shall be ASTM A307 Grade B with hexagon heads.

15. Flange Bolt Thread Lubricant: Lubricant shall be an antiseize compound designed for temperatures up to 1000°F and shall be Crane Anti-Seize Thread Compound or approved equal.

16. PEX-a: PEX-a(Engel-Method Crosslinked Polyethylene) BY UPONOR. Fittings shall be PEX-a, ASTM F1960, Connections are made using cold expansion method.

B. Miscellaneous Piping Materials/Products:

C. Welding Materials: Comply with ASME Boiler and Pressure Vessels Code, Section II, Part C, for welding materials.

E. Gaskets for Flanged Joints: 1/16" thick for all pipe size 10" and smaller and 1/8" thick for all pipe size 12" and larger. Ring-type shall be used between raised face flanges and full face-type between flat face flanges with punched bolt holes and pipe opening. Gaskets shall be Garlock Style 3400 compressed nonasbestos or equal.

F. Insulating (Dielectric) Unions: Provide dielectric unions at all pipe connections between ferrous and nonferrous piping. Unions shall be "Clearflow" waterway as made by Victaulic, "Delvin" as made by Pipeline Seal and Insulator Company or as manufactured by Watts Co.

G. Solder: All solder used for sweating of water piping joints shall be 95/5 tin-antimony or tin-silver. All solder used for sweating of natural gas piping joints shall be phosphorous-free, non-lead bearing silver brazing solder with a melting point in excess of 1000°F.

H. Threadsealing Tape: Threadsealing tape used for plumbing piping applications shall be stretched or nonstretched teflon tape. Threadsealing tape used for natural gas piping applications shall be nonstretched 0.004" thick teflon tape and shall be yellow in color for identification.

I. Copper piping sizes 1/2" through 4" may utilize mechanical press fittings manufactured by Viega and including the Smart Connect feature to ensure that unpressed fittings will be easily and reliably detected during testing. Installation will be in accordance with manufacturer's approved guidelines. Approved applications will be in accordance with manufacturer's current publication.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION:

A. General:

1. Industry Practices: Install pipe, tube, and fittings in accordance with recognized industry practices which will achieve permanently leak-proof piping systems, capable of performing each indicated service without failure or degradation of service. Install each run with a minimum of joints and couplings, but with adequate and accessible unions or flanged connections to permit disassembly for maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align accurately at connections, within 1/16" misalignment tolerance. Coordinate piping locations with other trades to avoid conflict. Give ductwork preference unless directed otherwise by the Engineer.

2. Systems: Install piping parallel or perpendicular to lines of building, true to line and grade, and with sufficient hangers to prevent sags between hangers. Provide fittings at changes in direction. Piping in finished areas shall be concealed, except in mechanical rooms. Where pipes of different sizes join, provide reducing elbows, tees, or couplings. Bushings will not be acceptable.

3. Expansion and Contraction: Install loops, offsets, sizing joints, and expansion joints, as necessary, to avoid strain resulting from expansion and contraction of piping systems on fixtures and equipment.
a. Expansion Loops and Offsets: Provide expansion loops and offsets in piping systems for not less than one inch (1") expansion or contraction per 100' of pipe.

4. Pipe Grading: Install domestic water piping to pitch down in the direction of flow for drainage. Grade storm, soil, and waste piping at 1/4" per foot whenever possible, and not in any case less than 1/8" per foot for pipe sizes 4" and larger, unless shown otherwise on the Drawings. Grade vent piping at 1/4" per foot whenever possible, and not in any case less than 1/8" per foot toward vents. Grade gas piping at a minimum of 1/8" per foot toward condensation traps at connected equipment.

B. Steel Pipe: Ream steel pipe after cutting and before threading. Thread with clean-cut taper threads of length to engage all threads in fittings and leave no full-cut threads exposed after make-up. Use John Crane or approved equal teflon thread tape applied only to male threads to make-up joints.

C. Copper Pipe: Cut copper pipe square and ream to remove burrs. Clean fitting socket and pipe ends with sand cloth, No. 00 cleaning pads or wire brush. No acids shall be used to clean either pipe or fittings or as a flux in sweating joints. The use of drilled T connections is not permitted.

D. PVC Pipe: Cut PVC pipe square and remove all burrs. Clean fitting and pipe butt prior to installation. Install all PVC piping in accordance with the manufacturer's recommendations.

E. Final Connections to Equipment Furnished by Owner or Under Other Divisions of These Specifications: Where Drawings show equipment to be furnished under other Divisions of these Specifications or by the Owner, such equipment will be delivered to the site, uncrated, assembled, and set in-place under those other Divisions of these Specifications or under the separate contracts. Any required automatic control valves shall also be provided under those other Divisions of these Specifications or other separate contracts. Make all final connections of chilled water, hot water, condenser water, gas, domestic water, waste, and vent as shown. Provide valves, unions, strainers, check valves, and traps as required for proper operation of systems and equipment. Equipment not shown or noted on the piping drawings shall not be included in the scope of this requirement.

F. Excavation, Installation, and Backfill for Underground Pipe:

1. Layout: Pipes shall be laid and pipe joints made in presence of the Owner's Representative and field measurements, layouts, battery board alignment, grade establishments, and similar locations shall be performed by a Professional Engineer in the employ of the Contractor. The Contractor's engineer shall be on the job during all underground work. A "Bench-Mark" reference for use by the Contractor shall be provided by the Owner.

2. Pipe Grading: Lay and maintain all pipes at required lines and grades during the course of the Work to comply with the Drawings.

3. Trench: Excavate the trench to the depth required. Properly brace and dewater the trench and keep it free of water during installation, testing pipe, and backfilling. No water shall be discharged onto a street or freeway without approval by the Architect. Refer to Section 230000 for additional requirements.
4. **Excavation:** The trench shall be at least 18" wider than the maximum diameter of the pipe or largest bell and the pipe shall be laid in the center of the trench. The trench shall be excavated to a depth sufficient to provide for pipe cushions or supports as specified with a minimum backfill cover of 30". Trench width may be increased as required and piling left in place until sufficient compacted backfill is in place. Properly sheet and brace all open trenches to render them secure and remove all such sheeting and bracing before completing the backfill. Comply with local regulations or, in the absence thereof, with the "Manual of Accident Prevention in Construction" of the Associated General Contractors of America, Inc. The quantity of excavation required to install sheeting and the installation and removal of sheetings and bracings will not be regarded as Extra Work. All costs incurred for this excavation and the installation of sheeting shall be included in the Contract Price. Refer to Section 23 00 00 for additional requirements.

5. **Grading:** Upon completion of excavation and prior to the laying of the pipe, the trench bottom shall be brought up to the required elevation with a pipe cushion, except where the cushion has been eliminated by the Engineer. Pipe cushions shall be select material deposited in the trench and shall be compacted, leveled off, and shaped to obtain a smooth compacted bed along the laying length of the pipe. Pipe cushion shall be as follows:

   a. **Stable, Firm Semidry Trench:** Piping shall be laid on undisturbed earth, in a constant uniformly sloped trench. Laying space for hubs or mechanical joints shall be hand cut to 6" either side of the joint and stabilized sand poured and wet in to even with the natural earth trench bottom. The leakproof integrity test of the piping system shall be inspected by the Owner's Representative prior to covering the piping. Failure to notify the Owner's Representative for inspection prior to covering the piping will result in the piping being uncovered and the test being performed again. Where the slope of the trench is found to belly down along the line of piping, before joining, the pipe shall be removed from the trench and the belly converted to uniform slope by adding stabilized bank sand, wet down and slightly mounded to the center of the trench. The section of piping will then be "rolled" into place so with support uniform along its entire length. Where the slope of the trench is found to arch up along the line of piping, before joining, the pipe shall be removed from the trench and the arch converted to uniform slope by cutting the arch out. The section of piping will then be reset into place with support uniform along its entire length.

   b. **Wet Clay - Black Gumbo:** Piping shall be laid in a constant, uniformly sloped trench. After shaping, the trench shall receive 3" minimum clean bedding sand, which shall be uniformly distributed on the trench bottom. Laying space for the hubs or mechanical joints shall then be hand removed and the piping placed on the setting bed with the weight of the piping distributed evenly on the setting bed over its entire length. The leak-proof integrity test of the piping system shall be inspected by the Owner's Representative prior to covering the piping by the Engineer's agent. Failure to notify the Owner's Representative for inspection prior to covering the piping will result in the piping being uncovered and the test performed again.

   c. **Rock:** Where rock is encountered, the trench shall be excavated to a
PLUMBING PIPING SYSTEMS

minimum of 6" below the pipe elevation and then backfilled with bedding sand to provide a uniform layer for pipe support. Backfill shall be as indicated for Wet Clay - Black Gumbo.

d. Special Considerations: Where there are expansive soil conditions on the site, special precautions shall be taken to prevent pushing and breakage of underground piping. Precautions shall be in accordance with local installation techniques and may include carton forms or special pipe bedding.

6. Anchors: Cast iron pipes shall have concrete anchors at each change in direction and/or as directed. Any change in direction exceeding 15 degrees shall be anchored. Concrete anchors shall rest against solid (virgin) ground with the required area of bearing on pipe and ground to provide suitable anchoring.

7. Backfill: Backfill trenches only after piping has been inspected, tested, and approved by the Architect. Place backfill material in the trench either by hand or approved mechanical methods. The compaction of backfill material shall be accompanied by tamping with hand tools or approved pneumatic tampers, by using vibratory compactors, by puddling, or by any combination of the three. The method of compaction shall be approved and all compaction shall be done to the satisfaction of the Architect. Backfill completely around pipe, including 18" above the pipe, with suitable bank sand, tamped in 4" layers under, around, and over pipe. Water down backfill as required. The remainder of the backfill for pipes shall be select backfill material tamped at intervals of no more than 12" depths, to attain a 95% Proctor Compaction Density. All materials to be used as select material backfill shall be approved by the Architect. If, in the opinion of the Architect, the excavated material does not meet the requirements of select material, the Contractor shall be required to screen the material prior to its use as select material backfill. Material used in the upper portion of the backfill or subgrade shall not contain stone, rock, or other material larger than 6" in its longest dimension. No wood, vegetable matter, or other material, which in the opinion of the Architect is unsuitable, shall be included in the backfill. The upper 24" of backfill may be water jetted, if desired. Bring backfill up to finish grade identified on the Architectural Drawings, including additional backfill required to offset settlement during consolidation. When removal of unsuitable, excavated material creates a shortage of backfill material, the Contractor shall, at no change in Contract amount, furnish material as specified in this Section in the amount required to complete the backfill.

8. Existing Surfaces: Restore existing streets, driveways, and sidewalks damaged during the excavation work to acceptable condition, subject to approval by the Architect.

9. Safety: Provide street and sidewalk excavations with approved barricades, warning lights, and cover plates as required by the City. Refer to Section 23 00 00 and Division 1 for additional requirements.

G. Pipe Fabrication Drawings:

1. Pipe fabrication drawings shall be submitted for all piping in the Mechanical Room and for Equipment connections and all other areas requiring coordination with other trades.
2. Pipe fabrication drawings shall be double line drawings to scale on 1/4" scale building floor plans and shall indicate pipe size, fittings, valves, accessories, connections, system type, insulation, support requirements, pipe elevations and other information required for coordination with other trades and fabrication of pipings.

3. Pipe fabrication drawings shall be coordinated with other trades and building construction prior to submittal for approval. Refer to Section 23 00 00 for additional shop drawing requirements.

H. Basic Materials and Methods: Refer to Section 23 00 00 for additional requirements related to plumbing piping.

3.2 PLUMBING SERVICES:

A. General: Install the various piping systems as described and as required by the local plumbing inspection department.

1. Slope domestic hot and cold water piping to drain and provide with hose valves (drain valves) at low points.

2. Install soil, waste, and vent piping with horizontal lines pitched in accordance with local codes, but in no case less than 1/4" per foot for pipe 3" and smaller and 1/8" per foot for pipe 4" and larger. Install soil, waste, and vent piping with hubs of each length of piping in the upstream position.

3. Provide chrome-plated piping at each fixture installed in a finished space. Install with proper strap wrenches to avoid marking or defacing.

4. Provide proper restraints on riser and stack offsets.

B. Plumbing Connections to Mechanical Equipment:

1. General: Provide necessary pipe and fittings. Make final connections to provide cold water make-up and natural gas supply to mechanical equipment. Locate cold water make-up and gas supply where shown and connect with suitable stop valves, check valves and bypass valves as applicable.

3.3 MAKE-UP WATER PIPING SYSTEMS:

A. Connections: Connect domestic water to automatic fill and manual quick-fill connections on each HVAC piping system and as shown on Drawings. Provide reduced pressure backflow preventers at each system.

B. Compatibility: Use piping and fittings of same material type as materials of the domestic water supply.

3.4 DOMESTIC HOT AND COLD WATER PIPING SYSTEMS:

A. Interior Hot and Cold Water Piping:

1. Schedule 40 PVC pipe and fittings with solvent weld joints.

2. Piping 3" and smaller, Type "L" copper tubing hard drawn with wrought copper lead free solder end fittings.

3. Provide isolation fitting whenever dissimilar materials are used.

4. Refer to the contract documents and drawings for more information.
B. Piping Runouts to Fixtures: Provide piping runouts to fixtures sized to comply with governing regulations. Where not otherwise indicated, provide runouts sized to comply with the following: lavatories - 1/2" hot, 1/2" cold; water closet flush valves - one and one half inch (1-1/2") cold; urinal flush valves - one inch (1") cold; drinking fountains - 1/2" cold. Provide each fixture with a shut-off valve for each supply line. All exposed lines shall be chromium-plated.

C. Shock Absorbers:
   1. Fixture Air Chambers: At each hot and cold water supply pipe at each fixture, provide a properly sized stainless steel welded nested bellows type shock absorber. Zum Shoktrol or approved equal sealed air chamber.

3.5 UNDERGROUND DOMESTIC WATER PIPING:
A. Service Piping: Schedule 40 PVC pipe and fittings with solvent weld joints.
B. Underslab Piping: All water piping under the building slab will be installed inside of a schedule 40 PVC sleeve.
C. Refer to the contract documents and drawings for more information.

3.6 SANITARY DRAINAGE SYSTEM:
A. Waste and Vent Piping: waste and vent piping shall be constructed of PVC schedule 40 pipe and fittings with solvent weld belled end per ASTM D-1785.
B. Waste and Vent Piping in return air plenum shall be cast iron and fitting assembled with No-Hub stainless steel clamp assemblies.
C. Cleanouts:
   1. Locations:
      a. At base of every drainage stack.
      b. Upper terminal of each horizontal drainage pipe.
      c. Each 90'length of horizontal straight run of drainage piping.
      d. Where shown on Drawings.
      e. As required by local code.
   2. Size: Cleanouts shall be line size for piping up to 4" and 4" size for piping larger than 4".
   3. Access: Provide access doors for access to cleanouts installed in concealed locations.
D. Fixture Connections:
   2. Lavatories: Copper or cast iron nipples with suitable adapters.

3.7 CHASE AND WALL PIPING SUPPORTS:
A. All piping whether sanitary or water shall be rigidly installed in all chases or walls. Test for rigidity shall be that the piping is virtually immovable by hand short of deforming the piping. Valve, stop and fixture penetrations thru chase or fixture mounting walls shall be firmly supported from just inside the wall or chase prior to penetration to the room-side of
the chase or wall.

B. Support inside the chase or wall for Sanitary Waste and Vent Piping shall be accomplished by utilizing fixture carrier bolt-downs, "Uni-Strut" or similar structural bracing system, "U-bolts", nuts and lock-washers, all bolted to the floor and to the piping system.

C. Support for Water Piping or other similar service piping shall be accomplished by using a "system" designed for that purpose. An approved system shall consist of preformed steel supports which shall be installed between studs or joists and preformed nonmetallic pipe holder inserts which are designed to rigidly support or hold the piping to the steel supports.

D. In no case shall Sanitary Sewer Waste or Vent Piping depend on blocks, brick, stone or wood sleepers for its final support. In no case shall Water Piping or similar service piping depend on its final support on "tie-wires", soldering or brazing to metal studs or joists, copper tube soldered to risers and tied to joists or any other method which does not have the written approval of the Engineer. Piping improperly supported shall have improper supports promptly removed and replaced with specified supports at the direction of the Engineer at no additional cost to the Owner and/or Architect/Engineer.

E. Support system shall be as manufactured by "Holdrite" or an approved equal.

3.8 CLEANING, FLUSHING, TESTING AND INSPECTING:

A. Cleaning: Clean exterior surfaces of installed piping systems and prepare surface for application of any required coatings.

B. Piping Tests:

1. General: Blank off equipment during tests. Perform tests before piping is enclosed in walls, floors, partitions or in any other way concealed from view. Tests may be performed in sections. Tests shall be witnessed by the Engineer or Owner's Representative and local inspectors and results presented to the Engineer for acceptance and approval prior to concealing piping from view. Provide all necessary equipment for testing, including pumps and gauges. Refer to Section 23 00 00 for additional requirements.

2. Domestic Water Systems: Test hot and cold water systems hydrostatically to a pressure of 150 psig or 1-1/2 times working pressure, whichever is greater, for a period of 24 hours. Repair all leaks, replacing materials as necessary, and repeat tests until systems are proven tight.

3. Soil, Waste and Vent Piping System: Test soil, waste, and vent piping by plugging all openings and filling system to height required by City Plumbing Inspector, but not less than 10' above the level of the pipe being tested, for a minimum of 3 hours. Inspect all joints for leaks, repair all leaks found, and retest until piping is demonstrated to be free from leaks as evidenced by no perceptible lowering of the water level after 3 hours. In addition to water test, apply peppermint or smoke tests, if required by local code.

4. Flushing: Flush water piping systems with clean water following successful testing. Refer to Section 23 00 00 for additional pipe cleaning and flushing requirements.

C. Disinfection of Water Systems: Disinfect hot and cold water systems as follows: Fill
systems with water solution containing 50 ppm available chlorine; allow to stand for 8 hours, opening and closing all valves several times during this period; thoroughly flush; refill and place system in service; ensure a residual chlorine content of 0.2 ppm. Refer to Section 2 for additional requirements.

D. Cleaning and Adjusting: Thoroughly clean and disinfect all plumbing fixtures, including all exposed trim. Adjust all flush valves for proper flushing, but without excess use of water. Demonstrate to the Engineer that the entire plumbing system and all its components are functioning properly.

E. Inspecting: Visually inspect each run of each system for completion of joints, adequate hangers, supports, and inclusion of accessories and appurtenances.

3.9 IDENTIFICATION:

A. Refer to Section 23 05 53 for applicable painting, nameplates, and labeling requirements.

END OF SECTION 22 10 00
1.1 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, Supplementary General Conditions, all applicable requirements of Division 1, “General Requirements”, and Section 230000, “Basic Mechanical Requirements”, govern this Section.

1.2 DESCRIPTION OF WORK:
A. Work Included: Provide plumbing piping valves and accessories as specified, and indicated.
B. Types: The types of plumbing piping valves and accessories required for the project include, but are not limited to:
1. Valves.
2. Strainers.
3. Unions.
4. Flanges.
5. Gaskets.
6. Flexible connections.
7. Drain pans.

1.3 QUALITY ASSURANCE:
A. Acceptable Manufacturers: The model numbers listed in the Specifications establish a level of quality and material. The following manufacturers are acceptable, subject to compliance with the requirements of these Specifications.
1. General Valves:
   a. Crane Company.
   c. Lunkenheimer.
   d. Nibco.
   e. Red and White.
   f. Stockham Valves and Fittings.
   g. Walworth Company.
   h. Milwaukee Valves.
2. Ball Valves:
   a. Apollo.
   b. Crane Company.
   d. Nibco.
   e. Red and White.
   f. Stockham Valves and Fittings.
   g. Victaulic.
   h. Milwaukee Valves.
3. Backflow Preventers/Pressure Reducing Valves:
   a. Febco.
   b. Hersey Products, Inc.
4. Check Valves:
   a. Crane Company.
   c. Mission.
   d. Muesco, Inc.
   e. Williams-Hager, Clow Pipeline Products, Valve Division.
   f. Victaulic.
   g. Milwaukee Valves.

5. Strainers:
   a. Crane.
   b. Keckley.
   c. Muesco.
   d. Victaulic.
   e. Zurn.

1.4 SUBMITTALS:
A. Shop Drawing submittals shall include, but not be limited to, the following:
1. Cut sheets on all valves, strainers, unions, flanges, gaskets, water meters, and gauges and thermometers, clearly showing all rating, capacities, and features.
2. Valve samples, when requested.
3. Additional information as required in Section 230000.

1.5 DELIVERY, STORAGE AND HANDLING:
A. Store plumbing piping valves and accessories in their factory-furnished coverings, and in a clean, dry indoor space which provided protection against the weather.

PART 2 - PRODUCTS

2.1 VALVES:
A. General: All valves shall be similar to numbers listed. All similar type and size valves shall be products of one manufacturer.

B. Applications: Valve application shall be as follows:

<table>
<thead>
<tr>
<th>Service</th>
<th>Application</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Water</td>
<td>Shutoff</td>
<td>Ball</td>
</tr>
<tr>
<td></td>
<td>Shutoff</td>
<td>Gate</td>
</tr>
<tr>
<td></td>
<td>Balancing</td>
<td>Globe</td>
</tr>
<tr>
<td></td>
<td>Check</td>
<td>Silent Check</td>
</tr>
</tbody>
</table>

C. Pressure Ratings:

<table>
<thead>
<tr>
<th>Service</th>
<th>Location</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Water</td>
<td>All</td>
<td>Refer to Section 221000</td>
</tr>
</tbody>
</table>

D. Insulated Piping: Stems on all valves installed in insulated piping shall be extended to allow adequate clearance between the operator and the insulation specified for the piping system when the valve is installed.

E. Chain Operators: Chain operators shall be provided for all valves installed over 8' above finished floor in the central plant, fan rooms, mechanical rooms and other areas where valves are exposed.
F. Flanges: Valve flanges and companion flanges for all valve applications shall be compatible with the valve rating and the system pressure at the point of application. Flanges shall conform to ANSI B16.1 and ANSI B16.10.

G. Butterfly Valves: Butterfly valves shall not be used for plumbing applications.

H. General Requirements:
   1. All valves shall be of threaded or flanged type. No solder connected valves on water lines shall be used on this project. All bronze and iron body gate and globe valves shall be of one manufacture for each project. Manufacturers of other types may not be mixed on the same project; i.e., all butterfly valves shall be of the same manufacture, all ball valves shall be of the same manufacture, etc.
   2. All valves at system points where the System Working Pressure (SWP) at the point of application, including appropriate pump shutoff head, does not exceed 150 psi, may use Class 150 valves.
   3. All bronze gate valves for pressures up to 150 psi shall be ASTM B62 composition bronze. Bronze valves for pressures above 150 psi shall be ASTM B61 steam bronze. All bronze valves shall be union or screw over bonnet, rising stem type with ASTM B99 alloy 651 or ASTM B371 alloy 694 or equal stem material.
   4. All bronze ball valves for pressures up to 300 psi shall be ASTM B62 composition bronze or ASTM B584 alloy 844.
   5. All iron body valves shall have the pressure containing parts constructed of ASTM A126 Class B cast iron. Stem material shall meet ASTM alloy 876 or ASTM 371 Alloy 876 silicon bronze or its equivalent. Gates and globes shall be bolted bonnet with OS&Y (outside screw and yoke) and rising stem design. A lubrication fitting shall be provided on yoke cap for maintenance lubrication of the yoke bushing.
   6. All valves shall be repackable, under pressure, with the valve in the full open position.
   7. All gate valves, globe valves, angle valves and shutoff valves of every character shall have malleable iron handwheels, except iron body valves 2-1/2" and larger which may have either malleable iron or ASTM A126 Class B, gray iron handwheels.
   8. Packing for all valves shall be selected for the pressure-temperature service of the valve. It is incumbent upon the manufacturer to select the best quality, standard packing for the intended valve service. At the end of one year period spot checks will be made, and should the packing show signs of hardening or causing stem corrosion then all valves supplied by the manufacturer shall be repacked at no expense to the Owner with a packing material selected by the Owner.
   9. Valves located with stem in horizontal position shall be drilled and tapped in accordance with MSS-SP-45 at Boss G to accommodate a drain valve.

I. Plumbing Valves For Domestic Water Service at or Less Than 150 PSIG: All domestic hot and water valves shall be certified lead free.
   1. Ball Valves:
      a. Ball valves shall be two pieces with a standard or full line size port chromium plated brass balls for domestic water, and 316 stainless steel balls for laboratory air and vacuum use, 316L stainless steel and stems and reinforced seats and stuffing box rings. All ball valves shall be designed to permit repacking while valve is in line. Valves shall be furnished with blowoutproof stems.
b. Ball valves 2” and smaller shall be threaded body bronze or brass valves of a full port design. Valves shall be rated for 300 psi WOG and shall conform to Federal Specification MSS_SP_110. Valves shall be:
1) Apollo No. 77-100 Series .
2) Crane No. 9032 Series.
4) Red and White No. 5044F Series.
6) Victaulic Style 722 .
7) Milwaukee No.BA-100 .
8) Milwaukee No. BA-400.

2. Gate Valves:
   a. Valves 2-1/2” and larger shall be flanged bronze mounted Class 125 iron body, outside screw and yoke gate valves with bolted bonnets and solid wedges. Valves shall be rated for 200 psi WOG and shall conform to MSS SP-70 and shall be:
      1) Crane No. 465-1/2.
      2) Jenkins No. 651-C.
      3) Lunkenheimer No. 1430.
      4) Nibco No. F-617-0.
      5) Red and White No. 421.
      7) Walworth No. 8726-F.
      8) Milwaukee No. F-2885 (-M).

3. Globe Valves:
   a. Globe valves 2” and smaller shall be 300 psi WOG rated, all bronze globe valves with renewable-regrindable stainless steel plug disk and seat ring, union bonnet, and threaded connections. Valves shall conform to MSS SP-70 and shall be:
      1) Crane No. 14-1/2-P.
      2) Jenkins No. 546-P.
      3) Lunkenheimer No. LQ-600-150.
      4) Nibco No. T-276-AP.
      6) Walworth No. 3237-P.
      7) Milwaukee No. 591A.
   b. Angle and Y-pattern globe valves corresponding to the standard globe valve models specified above may be used where more-suited to the installation location.
   c. Valves 2-1/2” and larger shall be flanged bronze mounted Class 125 iron body, outside screw and yoke globe valves with bolted bonnets and renewable seat and disc. Valves shall be rated for 200 psi WOG and shall conform to MSS SP-85 and shall be:
      1) Crane No. 351.
      2) Jenkins No. 613-B.
      3) Lunkenheimer No. 1123.
      4) Nibco No. F-718-B.
      5) Red and White No. 400.
      7) Walworth No. 8906-F.
      8) Milwaukee No. F-2981 (-M).
4. Check Valves:
   a. Check valves 2" and smaller shall be Class 150 threaded bronze swing check valves with horizontal swing and replaceable discs. Valves shall be rated for 300 psi WOG and shall conform to MSS SP-80 and shall be:
      1) Crane No. 141.
      2) Jenkins No. 352-C.
      3) Lunkenheimer No. 230.
      4) Nibco No. T-433.
      5) Red and White No. 238.
      7) Milwaukee No. 510S.
   b. Check valves 2-1/2" and larger shall be flanged bronze mounted Class 150 iron body swing check valves with bolted bonnets and renewable seat and disc. Valves shall be rated for 200 psi WOG and shall conform to MSS SP-71, Type 1 and shall be:
      1) Crane No. 373.
      2) Jenkins No. 624-C.
      3) Lunkenheimer No. 1790.
      4) Nibco No. F-918-B.
      5) Red and White No. 435.
      7) Walworth No. 8928-F.
      8) Milwaukee No. F-2974 (-M).
   c. All swing check valves shall be installed in vertical piping only. Allow adequate pipe clearance to allow for proper valve operation.

J. Valves for Automatic Water Make-up Connections: Valves 2" and smaller shall be Jenkins Fig. No. 900T or equal. Valves 2-1/2" and larger shall be Jenkins Fig. No. 632B, No. 632E or equal butterfly valve with operator.

K. Relief Valves: Temperature and pressure, self-closing, lever operated with thermo-bulb extension, 3/4", ANSI B.1 taper thread male inlet connection, 210°F (98.8°C) and 125 psig setting, ANSI Z1.22, Watts Regulator Company, Type No. 40XL or equal.

L. Combination Pressure Reducing and Relief Valves for Make-up Water: Bell and Gossett Model Number 3, dual unit or equal.

M. Reduced Pressure Backflow Preventer: Backflow preventers up to 2" shall be bronze body reduced pressure principal type with strainer and inlet and outlet gate valves, Clayton Model RP-2 or an approved equal. Backflow preventers 2-1/2" and larger shall be all bronze or epoxy coated cast iron with strainer and inlet and outlet OS&Y gate valves, Clayton Model RP-1 or an approved equal.

N. Flanges: Valve flanges and companion flanges for all valve applications shall be compatible with the valve rating and the system pressure at the point of application.

2.2 STRAINERS:

A. General: Water strainers shall be as follows:
   1. 150 psig Working Pressure: 150 psig working pressure, 2" and smaller, shall be Muessco No. 351 or equal, 200 pounds WOG, bronze body with perforated 20 mesh stainless steel screen with cleanout and screwed ends. 150 psig working pressure, 2-1/2" through 24", shall be Muessco No. 751 or equal, 150 pounds WOG, perforated stainless steel screen with 1/16" perforations for sizes through
2.3 UNIONS:

A. General: Provide in lines assembled with screwed and soldered fittings at points of connection to items of equipment and elsewhere as indicated or required to permit proper connections to be made or so that equipment may be removed. Unions shall also be provided in welded lines at the connections to items of equipment, where flanges are not provided.

1. Unions in steel lines assembled with screwed fittings shall be malleable iron screwed pattern unions with bronze seats. Unions in copper or brass lines shall be all brass, threaded pattern unions. Where unions are required by the above in steel lines assembled by welding, they shall consist of two mating welding flanges.

2. Dielectric unions shall be used at all junctures of dissimilar metals.

3. Unions in 2" and smaller in ferrous lines shall be Class 300 AAR malleable iron unions with iron to brass seats, and 2-1/2" and larger shall be ground flange unions. Unions in copper lines shall be 125 pounds ground joint brass unions or 150 pounds brass flanges if required by the mating item of equipment. Companion flanges on lines at various items of equipment, machines and pieces of apparatus shall serve as unions to permit removal of the particular items. See particular Specifications for special fittings and pressure.

2.4 FLANGES:

A. General: All 125/150 pound and 250/300 pound ANSI flanges shall be weld neck and shall be domestically manufactured, forged carbon steel, conforming to ANSI B16.5 and ASTM A-181 Grade I or II or ASTM A-105-71 as made by Tube Turn, Hackney or Ladish Company. Slip on flanges will not be acceptable. Each fitting shall be stamped as specified by ANSI B16.9 and, in addition, shall have the laboratory control number stenciled on each fitting for ready reference as to physical properties and chemical composition of the material. Complete test reports may be required for any fitting selected at random. Flanges which have been machined, remarked, painted or otherwise produced domestically from imported forgings or materials will not be acceptable. The flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Submit data for firm certifying compliance with these Specifications. Gaskets used shall be ring form, dimensioned to fit accurately within the bolt circle, shall be 1/16" thick, Manville service sheet packing Style 60. Inside diameter shall conform to the nominal pipe size. Bolts used shall be carbon steel bolts with semifinished hexagon nuts of American Standard Heavy dimensions. All-thread rods will not be an acceptable for flange bolts. Bolts shall have a tensile strength of 60,000 psi and an elastic limit of 30,000 psi. Flat faced flanges shall be furnished where required to match flanges on pumps, check valves, strainers, and similar items. Only one manufacturer of weld flanges will be approved for each project.

2.5 GASKETS:

A. General: Gaskets shall be placed between the flanges of all flange joints. Such gaskets shall be ring form gaskets fitting within the bolt circle of their respective flanges. Gaskets shall be 1/16" thick Manville Service Sheet Packing Style 60. The inside diameter of such gaskets shall conform to the nominal pipe size and the outside diameter shall be such that the gasket extends outward to the studs or bolts employed in the flanged joint.
PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Except as otherwise indicated, comply with the following requirements.

B. Isolation Valves: Provide isolation valves in domestic water systems at each run-out to a piece of equipment, each fixture, and elsewhere as shown on the Drawings.

C. Valve Stems: Install valves with stems pointed up, in the vertical position where possible, but in no case with stems pointed downward from a horizontal plane. All valves shall be located so as to make the removal of their bonnets possible. All flanged valves shown in the horizontal lines with the valve stem in a horizontal position shall be positioned so that the valve stem is inclined one bolt hole above the horizontal position. Screw pattern valves placed in horizontal lines shall be made up with their valve stems inclined at an angle of 30 degrees above the horizontal position. All valves must be true and straight at the time the system is tested for final acceptance. Valves shall be installed as nearly as possible in the locations as shown on and Drawings. Any change in valve location must be so indicated on the As-built Drawings.

D. Valve Chain Operators: Mechanical rooms where valves are installed over 8' above floor, provide chain operators.

E. Swing Check Valves: Swing check valves shall be installed in horizontal piping only.

F. Unions and Companion Flanges: Provide unions or companion flanges where required to facilitate dismantling of valves and equipment.

G. Access Doors and Panels: Provide access doors or panels as required to provide full valve access. Refer to Section 230000, "Basic Materials and Methods", for additional requirements.

H. Strainer Blowdown: Provide a blowdown valve with hose connection and cap at each strainer for blowdown.

3.2 IDENTIFICATION:

A. Refer to Section for applicable painting, nameplates, and labeling requirements.

END OF SECTION 221031
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including TPWD's Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes water-distribution piping and related components outside the building for Cedar Hill State Park.

1.3 DEFINITIONS
   A. EPDM: Ethylene propylene diene terpolymer rubber.
   B. LLDPE: Linear, low-density polyethylene plastic.
   C. PA: Polyamide (nylon) plastic.
   D. PE: Polyethylene plastic.
   E. PEX: Cross-linked polyethylene plastic.
   F. PP: Polypropylene plastic.
   G. PVC: Polyvinyl chloride plastic.
   H. HDPE: High Density Poly Ethylene
   I. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
   J. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 registered.

B. Regulatory Requirements:

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

C. Piping materials shall bear label, stamp, or other markings of specified testing agency.

D. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.

E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

F. NSF Compliance: As required by authorities having jurisdiction.

2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."
3. Comply with NSF 372, "Drinking Water System Components – Lead Content."

G. University of Southern California Foundation for Cross-Connection Control and Hydraulic Research (USC FCCCHR).


H. AWWA Compliance

1. Comply with AWWA C651 Standard for Disinfecting Water Mains
2. Comply with AWWA C901 Polyethylene (PE) Pressure Pipe and Tubing, 3/4 In. (19 mm) Through 3 In. (76 mm) for Water Service
3. Comply with AWWA C906 Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,600 mm), for Water Distribution and Transmission

1.7 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
1. Ensure that valves are dry and internally protected against rust and corrosion.
2. Plastic pipe and fittings shall be protected from the sun until installation.
3. Protect valves against damage to threaded ends and flange faces.
4. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves, including fire hydrants, according to the following:
   1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
   2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

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

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

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

1.8 PROJECT CONDITIONS
A. Interruption of Existing Water-Distribution 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 water-distribution service.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Gaskets: AWWA C111, rubber.

C. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.

1. Grooved-End, Ductile-Iron Pipe Appurtenances:
   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Anvil International, Inc.
      2) Victaulic Company of America.
   d. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

D. Flanges: ASME 16.1, Class 125, cast iron.

2.2 PVC PIPE AND FITTINGS

A. PVC, Schedule 40 Pipe: ASTM D 1785.
   1. PVC, Schedule 40 Socket Fittings: ASTM D 2466.

B. PVC, Schedule 80 Pipe: ASTM D 1785.
   1. PVC, Schedule 80 Socket Fittings: ASTM D 2467.
   2. PVC, Schedule 80 Threaded Fittings: ASTM D 2464.

2.3 HDPE PIPE AND FITTINGS

A. See Section 334105 – High Density Polyethylene (HDPE) Pipe and Fittings

2.4 JOINING MATERIALS

A. Refer to Section 330500 "Common Work Results for Utilities" for commonly used joining materials.

B. Brazing Filler Metals: AWS A5.8, BCuP Series.

C. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

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

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Tubular-Sleeve Pipe Couplings:

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

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

   a. Cascade Waterworks Manufacturing.
   b. Dresser, Inc.; Dresser Piping Specialties.
   c. Ford Meter Box Company, Inc. (The); Pipe Products Div.
   d. Hays Fluid Controls; a division of ROMAC Industries Inc.
   e. JCM Industries.
   f. Smith-Blair, Inc.
   g. Viking Johnson.

3. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.

   b. Gasket Material: Natural or synthetic rubber.
   c. Pressure Rating: 150 psig minimum.
   d. Metal Component Finish: Corrosion-resistant coating or material.

C. Flexible Connectors:

1. Nonferrous-Metal Piping: Bronze hose covered with bronze wire braid; with copper-tube, pressure-type, solder-joint ends or bronze flanged ends brazed to hose.

2. Ferrous-Metal Piping: Stainless-steel hose covered with stainless-steel wire braid; with ASME B1.20.1, threaded steel pipe nipples or ASME B16.5, steel pipe flanges welded to hose.

2.6 GATE VALVES

A. AWWA, Cast-Iron Gate Valves:

1. Nonrising-Stem, Metal-Seated Gate Valves:

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

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

   c. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
2. Nonrising-Stem, Resilient-Seated Gate Valves:

b. Description:

1) Standard: AWWA C500.

2) Minimum Pressure Rating: 250 psig.

3) End Connections: Mechanical joint.

4) Interior Coating: Complying with AWWA C550.

2. Nonrising-Stem, Resilient-Seated Gate Valves:

1) Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Industries, LLC; Wilkins; Model 48 (Lead Free) or comparable product by one of the following:

   a) Hammond Valve.
   b) KITZ Corporation.
   c) Milwaukee Valve Company.
   d) NIBCO, Inc.
   e) Red-White Valve Corporation

3. Nonrising-Stem, High-Pressure, Resilient-Seated Gate Valves:

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

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

   c. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
4) Crane Co.; Crane Valve Group; Stockham Div.
5) East Jordan Iron Works, Inc.
6) McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
7) McWane, Inc.; Kennedy Valve Div.
8) McWane, Inc.; M & H Valve Company Div.
9) McWane, Inc.; Tyler Pipe Div.; Utilities Div.
10) Mueller Co.; Water Products Div.
11) NIBCO INC.
12) U.S. Pipe and Foundry Company.

d. Description: Ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut.
   1) Standard: AWWA C509.
   2) Minimum Pressure Rating: 250 psig.
   3) End Connections: Push on or mechanical joint.
   4) Interior Coating: Complying with AWWA C550.

B. UL/FMG, Cast-Iron Gate Valves:

   1. UL/FMG, Nonrising-Stem Gate Valves:
      a. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Industries, LLC; Wilkins; Model 48 (Lead Free) or comparable product by one of the following:
         1) Hammond Valve.
         2) KITZ Corporation.
         3) Milwaukee Valve Company.
         4) NIBCO, Inc.
         5) Red-White Valve Corporation.

         b. Description:
            1) Standards: UL 262 and FMG approved.
            2) CWP Rating: 200 psig.
            3) Body Material: ASTM A 126, gray iron with bolted bonnet.
            4) Ends: Flanged.
            5) Disc: Solid wedge with resilient coating.
            6) Packing and Gasket: Asbestos free.

   2. OS&Y, Rising-Stem Gate Valves:
      a. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Industries, LLC; Wilkins; Model 48OSY (Lead Free) or comparable product by one of the following:
         1) KITZ Corporation.
         2) Milwaukee Valve Company.
3) NIBCO, Inc.
4) Red-White Valve Company.

b. Description:

1) Standards: UL 262 and FMG approved.
2) CWP Rating: 200 psig.
3) Body Material: ASTM A 126, gray iron with bolted bonnet.
4) Ends: Flanged.
5) Trim: All bronze.
6) Disc: Solid wedge with resilient coating.
7) Packing and Gasket: Asbestos free.

2.7 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
   b. East Jordan Iron Works, Inc.
   c. Flowserve.
   d. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
   e. McWane, Inc.; Kennedy Valve Div.
   f. McWane, Inc.; M & H Valve Company Div.
   g. Mueller Co.; Water Products Div.
   h. U.S. Pipe and Foundry Company.

4. Description: Sleeve and valve compatible with drilling machine.
   a. Standard: MSS SP-60.
   b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
   c. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.

1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.
C. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.

B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

C. Do not use flanges or unions for underground piping.

D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

E. Underground water-service piping shall be the following:
   1. PVC, Schedule PVC, Schedule 80 socket fittings; and solvent-cemented joints.
   2. PVC, AWWA Class 150 pipe; PVC, AWWA Class 150 fabricated fittings; and gasketed joints.

3.3 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.

B. Drawings indicate valve types to be used.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

A. See Section 330500 "Common Work Results for Utilities" for piping-system common requirements.

3.5 PIPING INSTALLATION

A. Water-Main Connection: Tap water main according to requirements of the drawings.
B. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

C. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.

D. Install fiberglass AWWA pipe according to AWWA M45.

E. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.

F. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.

   1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.

G. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

3.6 JOINT CONSTRUCTION

A. See Section 330500 "Common Work Results for Utilities" and Section 334105 “High Density Polyethylene (HDPE) Pipe and Fittings” for basic piping joint construction.

B. Make pipe joints according to the following:

   5. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners according to fitting manufacturer's written instructions.
   6. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
   7. Fiberglass Piping Bonded Joints: Use adhesive and procedure recommended by piping manufacturer.

3.7 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.
C. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

D. UL/FMG, Valves Other Than Gate Valves: Comply with NFPA 24.

E. MSS Valves: Install as component of connected piping system.

3.8 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.

1. Testing per TCEQ Current Regulations.

C. Prepare reports of testing activities.

3.9 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 “Earth Moving.”

3.10 CLEANING

A. Clean and disinfect water-distribution piping as per TCEQ Regulations.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 221113
SECTION 221313

FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections:
   1. Section 330500: Common Work Results for Utilities
   2. Section 034100: Precast Concrete
   3. Section 221113: Facility Water Distribution Piping
   4. Section 221333: Package Lift Station

1.2 SUMMARY

A. Section Includes:
   1. Pipe and fittings.
   2. Nonpressure and pressure couplings.
   3. Expansion joints and deflection fittings.
   4. Backwater valves.
   5. Cleanouts.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Expansion joints and deflection fittings.
   2. Backwater valves.

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.
1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

B. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.

C. Field quality-control reports.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Sewerage 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 owners requirement

PART 2 - PRODUCTS

2.1 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

A. Pipe: ASTM A 746, for push-on joints.

B. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.

C. Compact Fittings: AWWA C153, ductile iron, for push-on joints.

D. Gaskets: AWWA C111, rubber.

2.2 DUCTILE-IRON, PRESSURE PIPE AND FITTINGS

A. Push-on-Joint Piping:

1. Pipe: AWWA C151.
2. Standard Fittings: AWWA C110, ductile or gray iron.

B. Mechanical-Joint Piping:
1. Pipe: AWWA C151, with bolt holes in bell.
2. Standard Fittings: AWWA C110, ductile or gray iron, with bolt holes in bell.
4. Glands: Cast or ductile iron; with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.
5. Gaskets: AWWA C111, rubber, of shape matching pipe, fittings, and glands.

2.3 PVC PIPE AND FITTINGS

A. PVC Corrugated Sewer Piping:
   2. Fittings: ASTM F 949, PVC molded or fabricated, socket type.

B. PVC Profile Sewer Piping:
   2. Fittings: ASTM D 3034, PVC with bell ends.

C. PVC Type PSM Sewer Piping:
   1. Pipe: ASTM D 3034, SDR 26, PVC Type PSM sewer pipe with bell-and-spigot ends.
   2. Fittings: ASTM D 3034, PVC with bell ends.

D. PVC Gravity Sewer Piping:

E. PVC Water-Service Piping:
   1. Pipe: ASTM D 1785, Schedule 80 PVC, with plain ends for solvent-cemented joints.

   a. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide products by LASCO Fittings, Inc. or comparable products by one of the following:
   
   1) NIBCO, INC.
   2) Dura Plastics Products.

2.4 PRESSURE-TYPE PIPE COUPLINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Dresser, Inc.
3. Ford Meter Box Company, Inc. (The).
4. JCM Industries, Inc.
5. Romac Industries, Inc.
7. Victaulic Company.
8. Viking Johnson.

B. Tubular-Sleeve Couplings: AWWA C219, with center sleeve, gaskets, end rings, and bolt fasteners.

C. Metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include 200-psig minimum pressure rating and ends of same sizes as piping to be joined.

D. Gasket Material: Natural or synthetic rubber.

E. Metal Component Finish: Corrosion-resistant coating or material.

2.5 CLEANOUTS

A. Cast-Iron Cleanouts:

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

   b. MIFAB, Inc.
   d. Tyler Pipe; a subsidiary of McWane Inc.
   e. Watts; a Watts Water Technologies company.
   f. Zurn Industries, LLC.

2. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.

3. Top-Loading Classification(s): Heavy Duty.

4. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts:

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

   a. Canplas LLC.
   b. IPS Corporation.
   c. NDS Inc.
   d. Plastic Oddities.
   e. Sioux Chief Manufacturing Company, Inc.
2. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.6 PRECAST CONCRETE MANHOLES

A. Per Specification 034100 “Precast Concrete” and Section 221333 “Package Lift Station”.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 “Earth Moving.”

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, at slope as indicated on the drawings.
2. Install ductile-iron, gravity sewer piping according to ASTM A 746.
3. Install ABS sewer piping according to ASTM D 2321 and ASTM F 1668.
4. Install PVC cellular-core sewer piping according to ASTM D 2321 and ASTM F 1668.
5. Install PVC corrugated sewer piping according to ASTM D 2321 and ASTM F 1668.
6. Install PVC profile sewer piping according to ASTM D 2321 and ASTM F 1668.
7. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.
8. Install PVC gravity sewer piping according to ASTM D 2321 and ASTM F 1668.

G. Install force-main, pressure piping according to the following:
1. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.

2. Install piping with 48-inch minimum cover.

3. Install ductile-iron pressure piping according to AWWA C600 or AWWA M41.

4. Install ductile-iron special fittings according to AWWA C600.

5. Install PVC pressure piping according to AWWA M23 or to ASTM D 2774 and ASTM F 1668.

6. Install PVC water-service piping according to ASTM D 2774 and ASTM F 1668.

7. Install HDPE force main according to ANSI/WWA C901 and Section 334105 “High Density Polyethylene Pipe”.

H. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105:

2. Hubless cast-iron soil pipe and fittings.
3. Ductile-iron pipe and fittings.
4. Expansion joints and deflection fittings.

I. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping according to the following:

4. Join ductile-iron, gravity sewer piping according to AWWA D 2321 for push-on joints.
5. Join ABS sewer piping according to ASTM D 2321 and ASTM D 2751 for elastomeric-seal joints.
6. Join PVC cellular-core sewer piping according to ASTM D 2321 and ASTM F 891 for solvent-cemented joints.
7. Join PVC corrugated sewer piping according to ASTM D 2321.
8. Join PVC profile sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
9. Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
10. Join PVC gravity sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
11. Join fiberglass sewer piping according to ASTM D 4161 for elastomeric-seal joints.
14. Join dissimilar pipe materials with nonpressure-type, flexible or rigid couplings.

B. Join force-main, pressure piping according to the following:
   1. Join ductile-iron pressure piping according to AWWA C600 or AWWA M41 for push-on joints.
   2. Join ductile-iron special fittings according to AWWA C600 or AWWA M41 for push-on joints.
   3. Join PVC pressure piping according to AWWA M23 for gasketed joints.
   4. Join PVC water-service piping according to ASTM D 2855.
   5. Join dissimilar pipe materials with pressure-type couplings.

3.4 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.5 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
   1. Use Heavy-Duty, top-loading classification cleanouts in all areas.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.6 CONNECTIONS

A. Make connections to existing piping and underground manholes.
   1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
   2. Make branch connections from side into existing piping. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
      a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
      b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
   3. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
3.7 CLOSING ABANDONED SANITARY SEWER SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8-inch thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Backfill to grade according to Section 312000 "Earth Moving."

3.8 IDENTIFICATION

A. Comply with requirements in Section 312000 "Earth Moving" for underground utility identification devices. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.9 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 12 inches of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:
   a. Alignment: Less than full diameter of inside of pipe is visible between structures.
   b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
   c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
   d. Infiltration: Water leakage into piping.
   e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Force Main Testing

1. Hydrostatic testing of force mains shall be in accordance with 30 TAC §290.44(a)(5).

C. Leaks and loss in test pressure constitute defects that must be repaired. Contractor shall be responsible for cost of testing.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.
3.10 CLEANING

A. Clean dirt and superfluous material from interior of piping.

END OF SECTION 221313
SECTION 221319.13

SANITARY DRAINS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, Supplementary General Conditions, all applicable requirements of Division 1, "General Requirements", and Section 230000, "Basic Mechanical Requirements", govern this Section.

B. Work Included: Provide floor, area, and roof drains, and drain specialties and cleanouts as specified and scheduled.

C. Types: The types of drains and drain specialties required for this project include, but are not limited to:
   1. Floor drains/Floor drains.
   2. Cleanouts.
   3. Trap primers.

1.2 QUALITY ASSURANCE:

A. Acceptable Manufacturers: The model numbers listed in the Specifications establish a level of quality and material. The following manufacturers are acceptable subject to compliance with the requirements of these Specifications:
   2. Wade Division/Tyler Pipe.
   3. Zurn Industries, Inc.
   5. Mifab.

B. SUBMITTALS:

C. Shop Drawing submittals shall include, but not be limited to, the following:
   1. Cut sheets of drains and drain specialties clearly indicating all features, options, materials and dimensions.
   2. Additional information as required in Section 23 00 00.

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver drains and drain specialties in factory-fabricated water-resistant wrapping.

B. Handle drains and drain specialties carefully to avoid damage to material component, enclosure and finish.

C. Store drains and drain specialties in a clean, dry space and protect from the weather.
PART 2 - PRODUCTS

2.1 FLOOR DRAINS/FLOOR SINKS:
   A. General: Provide floor drains suitable for the type of construction and finishes at the point of application. Provide all drain accessories required for a complete installation, waterproofed where applicable.

   a. Floor drain basis of design shall be cast iron with a seepage flange, clamping unit, round adjustable polished nickel bronze strainer equal to J.R. Smith model number 2010C, the drain is to be provided with a trap guard equal to that manufactured by ProSeal.

   B. Provide floor drains and floor sinks equal in size, shape and model to those scheduled on the drawings.

2.2 CLEANOUTS:
   A. General: Provide cleanouts as shown on the drawings and as required by local ordinance. The size of the cleanouts shall be identical with the size of the soil or waste line in which they are placed for 4" and smaller lines. The size of cleanouts in lines larger than 4" shall be 4" in all cases. Coordinate cleanout style, mounting, flange, and clamping ring with the construction and finishes where the cleanout is located. Refer to Section 221000, "Plumbing Piping Systems", for additional requirements.

   B. Cleanouts (C.O.) in Finished and Unfinished Floors: Adjustable coated cast iron body, brass plug, secured round nickel bronze top, Carpet marker for carpeted areas, flangeless, flanged or flanged with clamping ring as required; Zurn No. ZN-1400-VP-BP or Jay R. Smith No. 4033-U (flangeless), No. ZN-1400-KVP-BP or Jay R. Smith No. 4033-3-F-U (flanged) or No. ZN-1400-KC-VP-BP or Jay R. Smith No. 4033 –FC-U (flanged with clamping ring) or approved equal.

   C. Cleanouts (C.O.) in Finished Walls: Coated cast iron cleanout body with brass pop-up relief cleanout plugs and square smooth nickel bronze cover plate and vandal proof securing screws; Zurn No. ZN-1443-VP-BP or Smith No. 4435-U or approved equal.

   D. Cleanouts (C.O.) in Exterior Lines: Traffic duty, coated cast iron cleanout with brass tapered thread cleanout plug, nickel bronze top and vandal proof screws. Install in minimum 12" x 12" x 4" concrete pad where not in paving; Zurn No. ZN-1400-HD-VP or Smith No. 4103-U or approved equal. Outside cleanout to have pop-up relief cleanout by Jones Stephens Corporation model S62-304 or equal.

2.3 TRAP PRIMERS:
   A. General: Provide trap guards on all floor drains in lieu of trap primers.

PART 3 - EXECUTION

3.1 INSTALLATION:
   A. Installation: Coordinate flashing work with work of other trades and Architectural details. Coordinate with roofing as necessary to interface roof drains with roofing work.

   B. Setting Locations: Install floor and roof drains in the low points of the surface areas to be drained. Set tops of drains flush with finished floor. Orient drain grates and cleanout covers to parallel floor tile lines where applicable.
C. Watertightness: Install drain flashing collar or flange so that no leakage occurs between drain and adjoining roofing or flooring. Maintain watertight integrity of penetrated waterproof membranes.

D. Accessibility: Position drains so that installed drains are accessible and easy to maintain.

E. Insulation: Refer to Section 23 07 19 for insulation of roof and floor drain bodies.

3.2 COORDINATION:

A. General: Coordinate the final location of all drains and cleanouts with the ascetics of construction. Center drains in showers, and other finished spaces, align drains with tile grids and conceal cleanouts in inconspicuous areas.

B. Notification: Where a cleanout must be located in an exposed area or a drain location cannot be centered in a space or located in the location shown on the Architectural Drawings, notify the Engineer in writing prior to proceeding with the installation.

END OF SECTION 221319.13
SECTION 221333

PACKAGE LIFT STATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, Standard General and Supplementary General Conditions, Division 01 Specification Sections, and other applicable Specification Sections including the Related Sections listed below, apply to this Section.

B. Related Sections:
   1. Section 230513: Motors
   2. Division 26: Electrical
   3. Section 034100: Precast Concrete

1.2 SUMMARY

A. Products specified in this section include the following:
   1. Submersible grinder sewage pumps
   2. Controls for the specified pumps
   3. Sump basins and covers
   4. Check valves and accessories for submersible pumps

1.3 SUBMITTALS

A. Product Data: Include catalog illustrations, model, rated capacities, performance, weights, dimensions, component sizes, rough-in requirements, piping and wiring diagrams and details, materials of construction, accessories, operating and maintenance clearance requirements. Wiring diagrams shall be project specific, and differentiate between factory wiring and field wiring. Include written sequence of operations for all controls.

B. Provide information for the following:
   1. Individual pump curves indicating flow rate, head, horsepower, and pump efficiency.
   2. Pump pipe connection size and type.
   3. Maximum passable solid size.
   4. Shaft seals, bearings, and cord sealing information.
   5. Motor insulation data.
7. Float information.
8. Control panel wiring diagrams.
9. Control panel face diagrams indicating components on the panel face and sides and how the components are labeled.
10. Float rod information.
11. Basin data, including depth, diameter; size, arrangement, and elevations of all openings; and data on gaskets and bushings to seal the cover and cover penetrations gas-tight.
12. Guide rail support system data.

C. Installation, Operation and Maintenance Manuals

1.4 QUALITY ASSURANCE STANDARDS

A. Manufacturers and Products: The products and manufacturers specified in this Section establish the standard of quality for the Work. Subject to compliance with all requirements, provide specified products from the manufacturers named in Part 2.

B. Reference Standards: Products in this section shall be built, tested, and installed in compliance with the specified quality assurance standards; latest editions, unless noted otherwise.
   1. American Water Works Association
   3. ANSI/HI 9.6.3-1997 Operating Region
   4. NEC-National Electrical Code
   5. National Electrical Manufacturers Association
   6. National Sanitation Foundation
   7. Underwriters Laboratories Inc. listed as a manufacturer of packaged pumping systems under UL/CUL Category QCZJ.
   8. Underwriters Laboratories Inc. listed as a manufacturer of control panels under UL/CUL 508a.
   9. UL Standard 778 Motor Operated Water Pumps

1.5 DELIVERY, STORAGE, AND HANDLING

A. Ship the pump and accessories in weather-proof wrap for storage outdoors. Protect control panels, pipe openings, and other sensitive components with heavy plastic or other durable means to ensure cleanliness and prevent damage during shipping and storage. Maintain protection during installation.

B. Comply with pump manufacturer's written rigging instructions for handling and installation.

1.6 WARRANTY

A. Provide a complete warranty for parts and labor for a minimum of one year from the date of Substantial Completion.
PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable Manufacturers:
   1. Liberty

2.2 SUBMERSIBLE DOUBLE SEAL CENTRIFUGAL GRINDER SEWAGE PUMPS

A. Pump Type: Duplex design, completely submersible, end-suction, close-coupled, overhung-impeller, centrifugal pump with controls. Capable of operating un-submerged without damage to pump. Factory-assembled and tested. 1-1/4 inch minimum discharge opening.

B. Impeller: Vortex style, uncoated, capable of passing solids. Statically and dynamically balanced cast or ductile iron, bronze, stainless steel, or engineered thermoplastic; keyed and secured to shaft. Provide hardened stainless-steel cutter/grinder with shredding device.

C. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical or horizontal discharge (as required for the project) for piping connection. Powder coated epoxy finish. All fasteners exposed to liquid shall be 300 series stainless steel. Provide stainless steel lifting handle. Provide lift ring (of stainless steel) and self-sealing discharge fittings for connection to guide-rail supports, when guide rail supports are indicated.


E. Cable-sealing assembly at pump connection: shall employ compression gland and epoxy potting of individual motor leads to prevent moisture from entering the motor housing if cord is damaged.

F. Pump and Motor Shaft: Stainless steel with factory-sealed, oil or grease-lubricated upper and lower ball bearings, to provide radial and thrust support.

G. Shaft Seals: Double mechanical seals. Lower and upper seals to be silicon carbide/silicon carbide. Provide seal moisture probes for leak detection.

2.3 PUMP CONTROLS:

A. Unless otherwise noted, provide UL listed controller/starter assembly with the following features for each pump.
   1. Float Switches: Provide multiple tethered style non-mercury mechanical style float switches to turn the pump on and off and to detect high level, with waterproof cables of length required. Provide float rod/pipe, tether clamps, and hardware, to secure the floats at the required elevations, all of stainless steel construction.

3. Controls: Provide UL listed controller/starter assembly. Provide a magnetic contactor (single phase pumps) or magnetic starter with adjustable overload protection (three phase pumps) that starts and stops the pump via float switch(es) separately wired to the control panel.
   a. Automatic Alternator (duplex pump arrangements): Electrical alternator that starts pumps on successive cycles and starts multiple pumps if one cannot handle load.
      Panel features (all mounted on panel face): control on/off switch, hand-off-auto switch and pump run light for each pump, high water alarm light, high water alarm test switch, seal failure light.
   c. Provide an audible alarm that activates upon high water or seal failure condition.
   d. Provide a latching dry auxiliary alarm contact for monitoring by the Owner’s building monitoring system, that energizes upon either a high water or seal failure condition.
   e. Provide an alarm silence button which deactivates the audible alarm but does not deactivate the local alarm lights or auxiliary alarm contact until the alarm condition clears.
   f. Provide motor disconnect for each motor, control transformer, control panel circuit breaker or fuse, numbered terminal strip(s) for all electrical connections, a project specific wiring diagram in a plastic pouch inside the panel, and all required accessories.
   g. Label all components on the exterior of the control panel with engraved plastic labels screwed to the panel face. Label all wiring, terminal strips, and electrical components inside the panels using labels made for that purpose.

2.4 SUMP BASINS AND BASIN COVERS

A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flanges and sidewall openings for pipe connections.
   1. Material: Precast Concrete per Section 034100 – Precast Concrete

B. Basin Covers: Basin covers shall be Precast concrete per Section 034100 – Precast Concrete

C. Basin Hatches: Shall be aluminum with locking hasp, safety grate and auto lock open support. Hatches to be manufacturer by Halliday Products or approved equal. Supplier of lift station wet well shall also provide the hatch cover.

2.5 ACCESSORIES

A. Check valves for sewage pumps and grinder sewage pumps:
   1. Non-slam resiliently hinged type check valve with peroxide cured EPDM disk, disk accelerator, and flanged connections; “SurgeBuster” as manufactured by Val Matic Valve and Manufacturing Corporation.
2.6 SOURCE QUALITY CONTROL

A. All pumps shall be factory tested. Verify all control panel functions. Verify pump grounding and integrity of winding insulation by megger testing. Run each pump submerged prior to shipment at maximum running point. Verify flow rate, head, amperage draw, and water tightness.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Examine roughing-in for equipment support, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting equipment performance, maintenance, and operations. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install in strict compliance with manufacturer's installation instructions and Related Sections. Maintain manufacturer's recommended clearances for service and maintenance.

B. Install separate devices furnished by manufacturer and not factory installed, including but not limited to float rods and floats, basins, basin covers and all related accessories, guide rail system, lift rods/cables, control panels, and any manufacturer's accessory devices necessary or recommended to meet the particular needs of the pump installation.

C. Protect basins from trash and debris at all times including during temporary service.

D. For all sewage and grinder sewage pump installations, regardless of pump connection size, provide minimum 2 inch diameter pipe (or larger as indicated) on the discharge side of each pump.

E. Provide a check valve and an isolation valve on each pump discharge pipe, near and above the basin cover or sump top rim level. Locate the check valve upstream of the isolation valve. Provide check valves of the type specified in Part 2.

F. Where discharge piping is below grade, locate the check and isolation valves outside of the basin in an accesses pit with access cover.

G. Run all power, float, and control wiring in conduit between basin cover and control panel. Seal inner diameter of conduit with sealing putty and connect to basin cover.
   1. Power cords of elevator sump pumps shall not be run in conduit. Connect directly to the non-GFCI outlet in the elevator hoistway that is controlled by the pump control panel. Install weatherproof cover on the outlet.

H. Verify proper pump rotation of pumps before installing in basins.
I. Adjust level control to prevent effluent in the sump basin from rising to within 2 inches of the invert of the lowest gravity drain inlet connection to the sump.

J. Adhere to manufacturer's start-up instructions.

3.3 TEMPORARY SERVICE

A. Start units for temporary use only with the expressed written permission of the Engineer and in compliance with all requirements of the Contract Documents.

B. Prior to placement into temporary service, perform manufacturer's pre-start protocols.

C. Commission equipment prior to putting into temporary service to the extent required by the Commissioning Authority. Re-perform all commissioning activities prior to Owner acceptance, even if previously commissioned to prepare for temporary service.

D. Perform all required routine maintenance procedures during temporary service. Continuously maintain a log of such procedures. Store the log at unit during temporary use period and include log as part of the final O&M manual.

3.4 FIELD QUALITY CONTROL

A. In the presence of the Commissioning Authority:
   1. Demonstrate the operation of the pump by filling the basin with water and verifying all functions of the pump and control panel. Provide temporary plugs in basin connections to allow filling the basin for testing. Remove plugs at completion of testing.

B. Provide a factory trained service technician to perform start-up services. The service technician shall perform the following:
   1. Verify correct installation and organize, instruct and assist the mechanical contractor's personnel in start-up procedures.
   2. Perform manufacturer's pre-start checks.
   3. Set all safety devices.
   4. Commission the pump package, including demonstrating all safeties, proper pump staging, alteration, and all other features.
   5. Provide a written service report prepared on site and submitted at the time of each service visit (with copies immediately provided to the Owner and Commissioner). Report shall indicate services provided and list all controller settings.
   6. Train Owner personnel. Training and start up services are separate functions and training shall not be combined with startup services.

3.5 TRAINING

A. Provide a qualified service technician from the Manufacturer's staff to provide training.
B. Train Owner's maintenance personnel on equipment operation, startup and shutdown, trouble-shooting, servicing and preventative maintenance procedures, pump access and pump removal. Review the data contained in the Operating and Maintenance Manuals with Owner's personnel.

1. Provide 2 hours training.

END OF SECTION 221333
SECTION 223437
DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, Supplementary General Conditions, all applicable requirements of Division 1, "General Requirements", and Section 230000, "Basic Mechanical Requirements", govern this Section.
B. Work Included: Provide electric water heaters as specified, scheduled, and indicated.
C. Provide solar powered water heater as specified, scheduled and indicated.

1.2 QUALITY ASSURANCE:
A. Manufacturers: Provide products of the following:
   2. A. O. Smith, Corp.
   4. Bradford White, Corp.
B. Electrical Standards: Provide electrical products which have been tested, listed, and labeled by Underwriters’ Laboratories, Inc. (UL) and which comply with National Electrical Manufacturers’ Association (NEMA) standards.

1.3 SUBMITTALS:
A. Shop drawing submittals shall include, but not be limited to, the following:
   1. Cut sheets on water heaters with capacities, electrical characteristics, features and options clearly indicated.
   2. Control and power wiring diagrams, sequence of operation, safety controls and FM and UL labels and listings.
   3. Manufacturers recommended installation instructions for water heater.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING:
A. Deliver electric water heaters in factory-fabricated water-resistant wrapping.
B. Handle electric water heaters carefully to avoid damage to material component, enclosure and finish.
C. Store electric water heaters in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 ELECTRIC WATER HEATERS:
A. General: Provide electric water heaters of the size, capacities and characteristics scheduled and shown on the Drawings. Provide a three (3) year warranty for the entire unit.
B. Elements: The heating elements shall be removable direct contact immersion type sealed in a zinc or tin-plated copper sheath or 80% nickel and 20% chromium sheath with a maximum density of 75 watts per square inch. Maximum size of individual heating element shall be 4.5 KW. Electric hot water heaters shall have multiple elements, minimum two, and a total element quantity as required to meet the specified capacity. Elements shall be wired for non-simultaneous operation if capacity is less than 4.5 kW.

C. Tanks: Heater shall be glass-lined steel tanks designed for a 150 psig working pressure and shall be vertical type. Heaters shall be factory insulated with polyurethane foam and jacketed. An anode rod and isolating inlet and outlet connections shall be provided for tank protection. A cold water dip tube shall be provided to replace water at the bottom of the tank.

D. Controls: Heaters shall be controlled with a thermostat through contactors if current requirements exceed thermostat capacity. Heaters shall have approved manual reset high limit thermostat to break all ungrounded conductors.

E. Accessories: Heaters shall be complete with suitable stand, drain, ASME temperature and pressure safety relief valves, and other items as required. In addition, provide an external slip-on jacket insulation.

PART 3 - EXECUTION

3.1 INSPECTION:
A. General: Installer shall examine the conditions under which the water heaters are to be installed and notify Contractor in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION:
A. General: Pipe and install water heaters as shown on the Drawings and in accordance with the manufacturer's written installation instructions. Water heaters shall be installed on a reinforced concrete housekeeping pad as specified in Section 230000, "Basic Materials and Methods", or be suspended with auxiliary drain pan installed.

B. Relief Piping: Provide a combination pressure and temperature relief valve (ANSI-21.22) and extend full size relief discharge piping from each water heater relief valve to the nearest floor drain or other approved point of safe discharge.

C. Space Requirements: Furnished equipment shall fit in the space provided as shown on the Drawings. A floor plan layout of the equipment installation shall be included in the shop drawing submittal.

D. Thermostat Adjustment: Adjust water heater thermostats to provide system water temperature as shown on the drawings.

3.3 IDENTIFICATION:
A. Refer to Section for applicable painting, nameplates, and labeling requirements.

END OF SECTION 223437
PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, Supplementary General Conditions, all applicable requirements of Division 1, "General Requirements", and Section 230000, "Basic Mechanical Requirements", govern this Section.

B. Work Included: Provide water conserving plumbing fixtures, trim, and accessories specified. Fixtures shall be complete with carriers, trim brass, flush valves, seats, stops, and other required accessories as specified herein or required. Trim for all sinks, lavatories, urinals, water closets, and showers shall comply with applicable water conservation standards.

1.2 QUALITY ASSURANCE:

A. Acceptable Manufacturers: The model numbers listed in the Specifications establish a level of quality and material. The following manufacturers are acceptable subject to compliance with the requirements of these Specifications.

1. Fixtures:
   b. Kohler Company.
   c. Toto

2. Faucets and Accessories:
   a. Chicago Faucet Company.
   b. Speakman Company.
   c. T & S Brass and Bronze Works, Inc.
   e. Symmons.
   g. Kohler Company.
   h. Eljer Plumbing Ware.
   j. Hydrotek.
   k. Moen.

3. Flush Valves:
   a. Sloan Royal XL Valves.
   b. Delany Flush Valves.
   c. Zurn Aquaflush Valves.
   d. Hydrotek.
   e. Toto.

4. Seats:
   a. Church Products, Forbes-Wright Ind., Inc.
   b. Olsonite Corporation.
   d. Centoco Mfg.
   e. Bemis.
5. Carriers:
   a. Zurn Industries, Inc.
   c. Wade Div./Tyler Pipe.
   d. Mifab.

6. Stainless Steel Sinks:

7. Hose Bibbs:
   a. Chicago Faucet Company.
   b. Woodford.
   c. Zurn Industries, Inc.

8. Trim (Traps, Supplies, Stops, Etc.):
   b. Eljer Plumbing Ware.
   c. Kohler Company.
   d. Chicago Faucet
   e. McGuire.

1.3 SUBMITTALS:
   A. Shop drawing submittals shall include, but not be limited to, the following:
      1. Fixture, brass, trim, closet seat, flush valve, water cooler and carrier cut sheets
         showing all features, finishes and options.
      2. Additional items as required in Section 230000.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING:
   A. Deliver plumbing fixtures and trim in factory-fabricated water resistant wrapping.
   B. Handle plumbing fixtures and trim carefully to avoid damage to material component,
      enclosure and finish.
   C. Store plumbing fixtures in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES:
   A. Provide plumbing fixtures suitable for the type of construction and finishes at the point
      of application. Provide all accessories required for a complete installation.
   B. Provide fixtures equal in size, shape and model to those scheduled on the drawings.

2.2 FIXTURE CARRIERS:
   A. All wall-hung plumbing fixtures shall be supported from floor-mounted carriers that are
      bolted to the floor. No wall-hung water closet, lavatory, urinal, drinking fountain or sink
      shall depend upon its support from the vertical building system.
   B. All fixture carriers in the building shall be the product of one manufacturer unless
      otherwise noted on the Drawings. In special instances and with the approval of the
      Engineer the foregoing may be waived in order to meet special building conditions.
   C. Carriers for wall-hung lavatories shall be concealed and be constructed of rectangular
      steel.
2.3 PROHIBITED LABELS AND IDENTIFICATION:
A. In all areas of the project, fixtures or accessories with markings or insignias intended to identify the vendor, or source must be out of plain view. Certification, testing, and approval labels are exceptions to this requirement.

2.4 EXPOSED PIPING:
A. All exposed piping for supply waste and vent connections to plumbing fixture and connected equipment in finished areas shall be polished chrome-plated unless noted otherwise on the Drawings. This shall include piping, fittings, and valves. Polished chrome-plated sleeves may be used over supply, waste, and vent piping provided that the finished installation presents the appearance of a fully chrome-plated system. Piping inside the chase is not considered exposed.

2.5 FIXTURE TRIM:
A. General: Trim shall be furnished as required for all fixtures and equal to that described in the schedule on the drawings.
B. Faucet Trim: Trim shall be constructed of all metal exposed components. All trim components on the pressure side of the faucet valves shall be metal construction.
C. Stops, Supplies and Traps: All stop valves shall be loose key. All risers shall be 16” Stainless steel supply connections by Fluidmaster. All P-traps shall be adjustable and have cleanout plugs. All stops, supplies, and traps shall have a finish to match the fixture brass.
D. Adjustable Cast Brass "P" Trap with Clean Out Plug:
1. 1-1/4" x 1-1/4": McGuire 8872
2. 1-1/4" x 1-1/2": McGuire 8902
3. 1-1/2" x 1-1/2": McGuire 8912
E. Closet, lavatory & sink:
1. Provide 1/4 turn McGuire LFBV02 or Chicago Faucet model no. 1017 stop with handles..

PART 3 – EXECUTION

3.1 INSTALLATION:
A. General: Install and adjust all fixtures in accordance with manufacturers written instructions.
B. Heights: Installation heights shall be specified in the Architectural Drawings.
C. Carriers: All wall hung fixtures shall have floor-mounted carriers.
D. Fixture Setting: Opening between fixture and floor/wall finish shall not exceed 1/8" and shall be caulked with white silicone caulk. Urinal and water closet sealing rings shall be resilient rubber. Wax sealing rings will not be acceptable.
E. Supports and Fastening: Secure all fixtures, equipment and trimmings to partitions, walls, etc., with brass through bolts, toggle bolts, expansion bolts, or power set fasteners, as required. Exposed heads of bolts and nuts in finished rooms to be hexagonal, polished chromium-plated brass with rounded tops.

F. Protection: Tightly cover and protect fixtures and trim from damage during construction. Replace any components which are damaged prior to Project Acceptance.

G. Cleaning: At completion of all work, fixtures, exposed materials and equipment shall be thoroughly cleaned.

H. Adjustment: Flush valves and other flow control devices shall be adjusted for proper operation prior to Project Acceptance.

I. Keys: Provide all loose stop and hose bibb keys to the Owner at Project Acceptance.

J. Insulation: Refer to Section 230719 for insulation of lavatory traps, tailpieces and hot and cold water supplies.

END OF SECTION 224000
SECTION 230000

BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES:
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, supplementary General Conditions and Division 1, “General Requirements” apply to this section. Basic Mechanical Requirements specifically applicable to Division 23 Sections.

1.2 WARRANTY
A. Warranties shall commence from the date of substantial completion of the project.
B. Warranties shall be for 1 year unless specifically called for differently within the specific specification section.
C. Warranty shall be unconditional and include material, labor and response within 24 hours of notification.

1.3 GENERAL:
A. The Contractor shall execute all work hereinafter specified or indicated on accompanying Drawings. Contractor shall provide all equipment necessary and usually furnished in connection with such work and systems whether or not mentioned specifically herein or on the Drawings.
B. The Contractor shall be responsible for fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to avoid all obstructions, to conform to the details of the installation and thereby to provide an integrated satisfactory operating installation.
C. The Mechanical, Electrical, and associated Drawings are necessarily diagrammatic by their nature, and are not intended to show every connection in detail or every pipe or conduit in its exact location. These details are subject to the requirements of standards referenced elsewhere in these specifications, and structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be organized and laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.
D. When the mechanical and electrical Drawings do not give exact details as to the elevation of pipe, conduit and ducts, the Contractor shall physically arrange the systems to fit in the space available at the elevations intended with proper grades for the functioning of the system involved. Piping, exposed conduit and the duct systems are generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat and workmanlike manner. The Drawings do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas.
1.4 DEFINITIONS:

A. (Note: These definitions are included here to clarify the direction and intention of this specification. The list given here is not by any means complete. For further clarification as required, contractor shall contact the designated Owner's representative.)

B. CONCEALED / EXPOSED: areas are those areas which cannot be seen by the building occupants. Exposed areas are all areas which are exposed to view by the building occupants, including under counters, inside cabinets and closets, plus all mechanical rooms.

C. General Requirements: The provisions of requirements of other Division 01 Sections apply to entire work of contract and, where so indicated, to other elements which are included in project. Basic contract definitions are included in the General Conditions.

D. Indicated: The term "indicated" is a cross reference to graphic representations, notes or schedules on drawings, to other paragraphs or schedules in the Specifications, and to similar means of recording requirements on contract documents. Where terms such as "shown", "noted", "scheduled", and "specified" are used in lieu of "indicated", it is for the purpose of helping reader locate the cross reference, and no limitation of location is intended except as specifically noted.

E. Directed, requested, etc.: Where not otherwise explained, terms such as "directed", "requested", "authorized", "selected", "approved", "required", "accepted", and "permitted" mean directed by Architect/Engineer", "requested by Architect/Engineer" and similar phrases. However, no such implied meaning will be interpreted to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.

F. And/Or: Where "and/or" is used in these Specifications or on the Drawings, it shall mean "that situations exist where either one or both conditions occur or are required and shall not be interpreted to permit an option on the part of the Contractor.

G. Approve: Where used in conjunction with Architect's/Engineer's response to submittals, requests, applications, inquiries, reports and claims by Contractor, the meaning of term "approved" will be held to limitations to Architect's/Engineer's responsibilities and duties as specified in General and Supplementary Conditions. In no case will "approval" by Architect/Engineer be interpreted as a release of Contractor from responsibilities to fulfill requirements of contract documents or to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.

H. As required: Where "as required" is used in these Specifications or on the drawings, it shall mean "that situations exist that are not necessarily described in detail or indicated that may cause the contractor certain complications in performing the work described or indicated. These complications entail the normal coordination activities expected of the Contractor where multiple trades are involved and new or existing construction causes deviations to otherwise simplistic approaches to the work to be performed. The term shall not be interpreted to permit an option on the part of the Contractor to achieve the end result."

I. Furnish:  
1. The term "furnish" is used to mean "supply and deliver to project site, ready for unloading, unpacking, assemble, installation, and similar operations."
2. Where "furnish" applies to work for which the installation is not otherwise specified, "furnish" in such case shall mean "furnish and install."
3. Install: The term "install" is used to describe operations at project site including "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operation."

4. Provide: The term "provide" means "to furnish and install, complete and ready for intended use."

1.5 PERMITS, UTILITY CONNECTIONS AND INSPECTIONS:

A. General: Refer to Division 01 for construction phasing and time increments.

B. Fees and Costs: If, during the course of the construction, a need arises to buy utilities, the Contractor shall pay all fees attendant thereto. If City or privately owned utility piping or electrical cable needs to be extended, relocated, or terminated, the Contractor will pay all permits and construction/inspection fees associated with that particular work.

C. All work performed on this project is under the authority of the State of Texas, therefore no local construction fees or construction permits will be required except as may be required for new service taps, or new or modified connections to City controlled services. If inspections by City personnel are specifically required by this document, then the Contractor is responsible for any fees or permits in connection to those requirements.

D. Compliance: The Contractor shall comply in every respect with all requirements of National Fire Protection Association, local Fire Department regulations and utility company requirements. In no case does this relieve the Contractor of the responsibility of complying with these Specifications and Drawings where specified conditions are of higher quality than the requirements of the above-specified authorities. Where requirements of the Specifications and Drawings are more lenient than the requirements of the above authorities having jurisdiction, the Contractor shall make installations in compliance with the requirements of the above authorities with no extra compensation.

1.6 CONTRACT DOCUMENTS:

A. All dimensional information related to new structures shall be taken from the appropriate Drawings. All dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the site.

B. The interrelation of the Specifications, the Drawings, and the schedules are as follows: The Specifications determine the nature and setting of the several materials, the Drawings establish the quantities, dimensions and details, and the schedules give the performance characteristics. If the Contractor requires additional clarification, he shall request it in writing, following the contractually prescribed information flow requirements.

C. Should the Drawings or Specifications conflict within themselves, or with each other, the better quality, or greater size or quantity of work or materials shall be performed or furnished.

1.7 FUTURE WORK

A. Provide for future work under requirements of Section 011100.

1.8 ALTERNATES

A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at the Owner's option. Accepted Alternates will be identified in Owner-Contractor Agreement.

B. Coordinate related work and modify surrounding work as required.
1.9 SUBMITTALS

A. Refer to Uniform General Conditions.

B. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories in a single submittal.

C. Mark dimensions and values in units to match those specified.

D. Submit Fabrication Drawings whenever (1) equipment proposed varies in physical size and arrangement from that indicated on the Drawings, thus causing rearrangement of equipment space, (2) where tight spaces require extreme coordination between ductwork, piping, conduit, and other equipment, (3) where called for elsewhere in these Specifications; and (4) where specifically requested by the Architect/Engineer. Fabrication Drawings shall be made at no additional charge to the Owner or the Architect/Engineer.

E. All required Fabrication Drawings, except as noted otherwise, shall be prepared at a scale of not less than 1/4" = 1'-0". Fabrication Drawings for ductwork, air handling units, and sections in Mechanical Rooms shall be drawn at a minimum scale of 3/8" = 1'-0". Submit three blueline prints of each Fabrication Drawing to the Architect/Engineer for review. Reproduction and submittal of the Construction Documents is not acceptable. The Architect/Engineer will review the drawing and return one print with comments.

1.10 SUBSTITUTION OF MATERIALS AND EQUIPMENT:

A. Refer to General Conditions for substitution of materials and equipment.

B. It is not the intent of the Drawings and/or Specifications to limit products to any particular manufacturer nor to discriminate against an "APPROVED EQUAL" product as produced by another manufacturer. Some proprietary products are mentioned to set a definite standard for acceptance and to serve as a reference in comparison with other products. When a manufacturer's name appears in these Specifications, it is not to be construed that the manufacturer is unconditionally acceptable as a provider of equipment for this project. The successful manufacturer or supplier shall meet all of the provisions of the appropriate specification(s).

C. The specified products have been used in preparing the Drawings and Specifications and thus establish minimum qualities with which substitutes must at least equal to be considered acceptable. The burden of proof of equality rests with the Contractor. The decision of the designer is final.

D. When requested by the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. In some cases, samples of both the specified item and the proposed item shall be provided for comparison purposes.

E. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop Drawings, and sample processing is on the Contractor. The Contractor shall allow a minimum of six (6) weeks time frame for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles of data processing, including time for all resubmittal cycles on unacceptable materials, equipment, etc. covered by the data submitted. Construction delays and/or lack of timeliness in the above regard are the responsibility of the
Contractor and will not be considered in any request for scheduled construction time extensions and/or additional costs to the Owner.

F. All equipment installed on this project shall have local representation, local factory authorized service, and a local stock of repair parts.

G. Acceptance of materials and equipment will be based on manufacturer's published data and will be tentative subject to the submission of complete shop Drawings indicating compliance with the contract documents and that adequate and acceptable clearances for entry, servicing, and maintenance will exist. Acceptance of materials and equipment under this provision shall not be construed as authorizing any deviations from the Specifications, unless the attention of the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.

H. Certification: The Contractor shall carefully examine all data forwarded for approval and shall sign a certificate to the effect that the data has been carefully checked and found to be correct with respect to dimensions and available space and that the equipment complies with all requirements of the Specifications.

I. Physical Size of Equipment: Space is critical; therefore, equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless it can be demonstrated that ample space exists for proper installation, operation, and maintenance.

J. Materials and Equipment Lists: Eight (8) copies of the list of materials and equipment, the name of manufacturer, trade name, type, and catalog number shall be submitted to the Architect/Engineer. The lists shall be accompanied by eight (8) sets of pictorial and descriptive data derived from the manufacturers' catalogs, sales literature, or incorporated in the Shop Drawings. Such lists shall include but will not be limited to the following items:

1.11 MATERIALS AND WORKMANSHIP:

A. All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use, and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of work involved. All work shall be executed by mechanics skilled in their respective trades, and the installations shall provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job site but shall be replaced with new materials and/or equipment.

B. The responsibility for the furnishing of the proper equipment and/or material and seeing that it is installed as intended by the manufacturer, rests entirely upon the Contractor who shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

1.12 FLAME SPREAD PROPERTIES OF MATERIALS:

A. Materials and adhesives incorporated in this project shall conform to UL723 and ASTM E84, "Method of Test of Surface Burning Characteristics of Building Materials" and NFPA 90. The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke developed rating of 50 for all materials to be located within a return air plenum.
1.13 REGULATORY REQUIREMENTS

A. Installation of mechanical systems shall be performed by individuals licensed by the Texas State Board of Mechanical Examiners. Installation may be performed by an Apprentice provided they are registered with the Texas State Board of Mechanical examiners and under direct supervision of a licensed. All installation shall be supervised by a licensed Mechanical Contractor.

B. The "Authority Having Jurisdiction" over the project described by these documents is the Owner, as an Agency of the State of Texas. As such, it is required that the installation shall meet the minimum standards prescribed in the latest editions of the following listed codes and standards, which are made a part of these Specifications. All referenced codes and standards shall be those current at the date of issue of the design documents.

C. National Fire Protection Association Standards (NFPA):
   1. NFPA No. 70, National Electrical Code
   4. UL723 and ASTM E84, Method of Test of Surface Burning Characteristics of Building Materials
   5. NFPA No. 258, Standard Research Test Method for Determining Smoke Generation of Solid Materials

D. American National Standards Institute (ANSI):
   1. A40.8, National Plumbing Code
   2. B31.1, Power Piping

E. American Gas Association Publications (AGA): Directory of Approved Gas Appliances and Tested Accessories

F. American Society of Mechanical Engineers (ASME): Boiler and Pressure Vessel Codes

G. Air Conditioning and Refrigeration Institute Standards (ARI): All standards related to refrigeration and air conditioning equipment and piping furnished under these Specifications.

H. Air Moving and Conditioning Association (AMCA): All current editions of applicable manuals and standards.


J. American Water Works Association (AWWA): All current editions of applicable manuals and standards.

K. National Electrical Manufacturers' Association (NEMA): All current editions of applicable manuals and standards.

L. International Building Code, (Includes the International Mechanical and International Plumbing Codes)

M. Texas Occupational Safety Act: All applicable safety standards

N. Occupational Safety and Health Act (OSHA)

O. ADA and ANSI Standards: All work shall be in accord with all regulations and requirements of the Standards and Specifications for Handicapped and Disabled for the Construction of Public Buildings and Facilities in the State of Texas Usable by Physically
Handicapped and Disabled persons, ANSI Standards and the requirements of the American Disabilities Act.

P. Refer to Specification Sections hereinafter bound for additional Codes and Standards.

Q. All materials and workmanship shall comply with all applicable state and national codes, Specifications, and industry standards. In all cases where Underwriters Laboratories, Inc. has established standards for a particular type material, such material shall comply with these standards. Evidence of compliance shall be the UL "label" or "listing" under Re-Examination Service.

R. The Contract Documents are intended to comply with the aforementioned rules and regulations; however, some discrepancies may occur. Where such discrepancies occur, the Contractor shall immediately notify the Architect/Engineer in writing of said discrepancies and apply for an interpretation. Should the discovery and notification occur after the execution of a contract, any additional work required for compliance with said regulations shall be paid for as covered by Division 01 of these Contract Documents, providing no work of fabrication of materials has been accomplished in a manner of noncompliance. Should the Contractor fabricate and/or install materials and/or workmanship in such a manner that does not comply with the applicable codes, rules and regulations, the Contractor who performed such work shall bear all costs arising in correcting these deficiencies to comply with said rules and regulations.

S. Texas Parks and Wildlife (TPWD) Uniform General Conditions (UGC): Contractor is responsible for following all requirements in the owners (TPWD) UGC. The stricter of these requirements or the owners UGC requirements shall be followed. Where UGC is in conflict with these specifications the contractor shall submit an RFI asking for direction from the Engineer. Where requirements are in the UGC but not in these specifications the UGC requirements shall be followed.

1.14 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS:

A. Storage at Site: The Contractor shall not receive material or equipment at the job site until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage.

B. Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.

C. Conformance with Agency Requirements: Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriters Laboratories, Inc., or constructed and/or tested in accordance with the standards of the American Society of Mechanical Engineers or the Air Moving and Conditioning Association, the Contractor shall submit proof that the items furnished under this Section of the Specifications conform to such requirements. The label of the Underwriters Laboratories, Inc., applied to the item will be acceptable as sufficient evidence that the items conform to such requirements. The ASME stamp or the AMCA label will be acceptable as sufficient evidence that the items conform to the respective requirements.

D. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating. The treatment shall withstand 200 hours in salt spray fog test, in accordance with Method 6061 of Federal Standard No. 141. Immediately after completion of the test, the specimen shall show no signs of wrinkling or cracking and no signs of rust creepage beyond 1/8" on either side of the scratch mark. Where rust inhibitor coating is specified
hereinafter, any treatment that will pass the above test is acceptable unless a specific coating is specified except that coal tar or asphalt type coating will not be acceptable unless so stated for a specific item. Where steel is specified to be hot-dip galvanized, mill-galvanized sheet steel may be used provided all raw edges are painted with a zinc-pigmented paint conforming to Military Specification MIL-P-26915.

E. Verification of Dimensions: The Contractor shall be responsible for the coordination and proper relation of his work to the building structure and to the work of all trades. The Contractor shall visit the premises and become thoroughly familiar with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Architect/Engineer of any discrepancy before performing any work. Adjustments to the work required in order to facilitate a coordinated installation shall be made at no additional cost to the Owner or the Architect/Engineer.

1.15 SLEEVES, INSERTS, AND FASTENINGS:
A. See Section 230529 – Sleeves, Flashings, Supports and Anchors.

1.16 PROJECT/SITE CONDITIONS
A. Install Work in locations shown on Drawings, unless prevented by Project conditions.
B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of Owner and Architect/Engineer before proceeding.

1.17 MANUFACTURER’S RECOMMENDATIONS
A. The manufacturer's published directions shall be followed in the delivery, storage, protection, installation, piping, and wiring of all equipment and material. The Contractor shall promptly notify the Architect/Engineer, in writing, of any conflict between the requirements of the Contract Documents and the manufacturer’s directions, and shall obtain the Architect/Engineer’s instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer’s directions or such instructions from the Architect/Engineer, he shall bear all costs arising in connection with the deficiencies.

1.18 PROTECTION:
A. The Contractor shall at all times take such precautions as may be necessary to properly protect all materials and equipment from damage from the time of delivery until the completion of the work. This shall include the erection of all required temporary shelters and supports to adequately protect any items stored in the open on the site from the weather, the ground and surrounding work; the cribbing of any items above the floor of the construction; and the covering of items in the incomplete building with tarpaulins or other protective covering; the installation of electric heaters in electrical switchgear and similar equipment to prevent moisture damage. Failure on the part of the Contractor to comply with the above will be sufficient cause for the rejection of the items in question.
B. Take particular care not to damage the building structure in performing work. All finished floors, step treads, and finished surfaces shall be covered to prevent any damage by workmen or their tools and equipment during the construction of the building.
C. Equipment and materials shall be protected from rust both before and after installation. Any equipment or materials found in a rusty condition at the time of final inspection must be cleaned of rust and repainted as specified elsewhere in these Specifications.

1.19 COOPERATION BETWEEN TRADES AND WITH OTHER CONTRACTORS:

A. Each trade, subcontractor, and/or Contractor must work in harmony with the various other trades, subcontractors and/or Contractors on the job as may be required to facilitate the progress to the best advantage of the job as a whole. Each trade, subcontractor, and/or Contractor must pursue its work promptly and carefully so as not to delay the general progress of the job. This Contractor shall work in harmony with Contractors working under other contracts on the premises.

1.20 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT:

A. The Contractor shall note that the electrical design and Drawings are based on the equipment scheduled and indicated on the Drawings, and should any mechanical equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

B. The Electrical Trades shall provide all interconnecting wiring for the installation of all power. The Electrical Trades shall provide all disconnect switches as required for proper operation, as indicated on the Drawings or required by applicable code. All combination starters, individual starters, and other motor starting apparatus not specifically scheduled or specified as provided by the equipment manufacturer under the scope of Division 23, shall be provided under the scope of Division 26.

C. The Mechanical Trades shall provide complete wiring diagrams indicating power wiring and interlock wiring. Diagrams shall be submitted to the Architect/Engineer for review within thirty (30) days after the submittals for equipment have been reviewed. Diagrams shall be based on accepted equipment and shall be complete full phase and interlock control Drawings, not a series of manufacturer’s individual diagrams. After these diagrams have been reviewed by the Architect/Engineer, copies shall be transmitted to the Electrical Trades by the Contractor. They shall be followed in detail. See Section 230923, TEMPERATURE CONTROLS, for additional clarification.

1.21 SUPERVISION:

A. Each Contractor and subcontractor shall keep a competent superintendent or foreman on the job at all times. (Refer to the Uniform General Conditions for additional information concerning supervision.)

B. It shall be the responsibility of each superintendent to study all Drawings and familiarize himself with the work to be done by other trades. He shall coordinate his work with other trades and before material is fabricated or installed, make sure that his work will not cause an interference with another trade. Where interferences are encountered, they shall be resolved at the job site by the superintendents involved. Where interferences cannot be resolved without major changes to the Drawings, the matter shall be referred to the A/E for ruling.
1.22 SITE OBSERVATION:
A. Site observation by the Architect/Engineer is for the express purpose of verifying compliance by the Contractor with the Contract Documents and shall not be construed as construction supervision or indication of approval of the manner or location in which the work is being performed as being a safe practice or place.

1.23 PRECEDENCE OF MATERIALS
A. The specifications determine the nature and setting of materials and equipment. The drawings establish quantities, dimensions and details.
B. The installation precedence of materials shall be as follows. Note that if an interference is encountered, this shall guide the contractor in the determination of which trade shall be given the “Right-of-Way.”
   1. Building lines
   2. Structural Members
   3. Soil and Drain Piping
   4. Vent Piping
   5. Domestic Water (Cold and Hot)
   6. Electrical Conduit

1.24 INSTALLATION METHODS:
A. Where to Conceal: All pipes, conduits, etc., shall be concealed in pipe chases, walls, furred spaces, or above the ceilings of the building unless otherwise indicated.
B. Where to Expose: In mechanical rooms, janitor’s closets tight against pan soffits in exposed “Tee” structures, or storage spaces, but only where necessary, piping may be run exposed. All exposed piping shall be run in the most aesthetic, inconspicuous manner, and parallel or perpendicular to the building lines.
C. Support: All piping, ducts and conduits shall be adequately and properly supported from the building structure by means of hanger rods or clamps to walls as herein specified.
D. Maintaining Clearance: Where limited space is available above the ceilings below concrete beams or other deep projections, pipe and conduit shall be sleeved through the projection where it crosses, rather than hung below them in a manner to provide maximum above-floor clearance. Sleeves shall be as herein specified. Approval shall be obtained from the Architect/Engineer for each penetration.
E. All pipe, conduits, etc., shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All ducts, pipes and conduits run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch. Piping, ducts and conduits run in furred ceilings, etc., shall be similarly installed, except as otherwise shown. Conduits in furred ceilings and in other concealed spaces shall be neatly grouped and racked indicating good workmanship. All conduit and pipe openings shall be kept closed until the systems are closed with final connections.
   1. All piping in this package shall be considered “exterior piping” and shall be as specified for “underground Piping” in Specification Section 232000A.

1.25 RECORDS FOR OWNER:
A. The Contractor shall maintain a set of “blueline” prints in the Field Office for the sole purpose of recording “installed” conditions. Daily note all changes made in these
TPWD Cedar Hill State Park Flood Repairs
TPWD No. 128269
HZ No. R302179.02

BASIC MECHANICAL REQUIREMENTS

1.26 CUTTING AND PATCHING:

A. General: Cut and patch walls, floors, etc., resulting from work in existing construction or by failure to provide proper openings or recesses in new construction.

B. Methods of cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the

Drawings in connection with the final installation including exact dimensioned locations of all new underground utilities, services and systems and all uncovered existing active and inactive piping outside the building.

B. At contract completion, the Contractor shall provide a set of reproducible photographic mylar drawings, plus the photo negatives of the revised drawings. The contractor shall transfer the information from the "blueline" prints maintained as described above, and turn over this neatly marked set of reproducible Drawings representing the "as installed" work to the Architect/Engineers for verification and subsequent transmittal to the Owner. The Contractor shall refer to Division 01 of these Specifications, and to the Uniform General Conditions, for additional information. These Drawings shall include as a minimum:

1. Addendum written drawing changes.
2. Addendum supplementary drawings.
3. Accurate, dimensioned locations of all underground utilities, services and systems.
4. Identification of equipment work shown on Alternates as to whether alternates were accepted and work actually installed.
5. Change Order written drawing changes.

C. Electronic Media:

1. In lieu of the drawings described above in 1.33B, it is preferred the contractor submit one set of blueline prints, one set of vellum reproducible, and one set of discs containing all the drawings in AUTOCAD 2010 or later format.

D. "As installed" mylars shall bear a stamp, "stick on decal", or lettered title block generally located in lower right hand corner of Drawing entitled "AS INSTALLED DRAWING" with Company name of the installing trade Subcontractor and with a place for the date and the name of the responsible company representative.

E. In addition to the above, the Contractor shall accumulate during the progress of the job the following data, in duplicate, prepared in a neat brochure or packet folder and turn over to the Architect/Engineer for review, and subsequent delivery to the Owner.

1. All warranties and guarantees and manufacturers' directions on equipment and material covered by the Contract.
2. Two sets of operating instructions for heating and cooling and other mechanical and electrical systems. Operating instructions shall also include recommended preventative maintenance and seasonal changeover procedures.
3. Valve tag charts and diagrams specified herein.
4. Approved wiring diagrams and control diagrams representing "as installed" conditions.
5. Copies of approved Shop Drawings.
6. Any and all other data and/or drawings required as submittals during construction.
7. Repair parts list of all major items and equipment including name, address and telephone number of local supplier or agent.
Architect/Engineer. Impact-type equipment shall not be used except where specifically acceptable to the Architect/Engineer. Openings in precast concrete slabs for pipes, conduits, outlet boxes, etc., shall be core drilled to exact size.

C. Restoration: All openings shall be restored to "as-new" condition under the appropriate Specification Section for the materials involved, and shall match remaining surrounding materials and/or finishes.

D. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.

E. Plaster: All mechanical work in areas containing plaster shall be completed prior to the application of the finish plaster coat. Cutting of finish plaster coat will not be permitted.

F. Special Note: No cutting, boring, or excavating which will weaken the structure shall be undertaken.

1.27 EXCAVATION, TRENCHING AND BACKFILL:

A. Excavation (See Divisions 00 and 01 for special requirements related to excavation and trenching.):

1. The Mechanical and Electrical subcontractors shall perform all excavations of every description, for their particular installations and of whatever substances encountered, to the depths indicated on the Drawings and/or required for the installation of piping, conduit, utility systems, etc. All exterior lines shall be installed with a minimum cover of 24", unless otherwise indicated. Generally, more cover shall be provided if grade will permit. All excavation materials not required for backfill or fill shall be removed and wasted as acceptable to the Construction Inspector. All excavations shall be made only by open cut. The banks of trenches shall be kept as nearly vertical as possible and where required, shall be properly sheeted and braced. Trenches shall be not less than 12" wider nor more than 16" wider than the outside edges of the pipe to be laid therein, and shall be excavated true to line so that a clear space not less than 6" nor more than 8" in width is provided on each side of the pipe. For sewers, the maximum width of trench specified applies to the width at and below the level may be made as wide as necessary for sheeting and bracing, and the proper installation of the work.

2. The bottom of trenches shall be accurately graded to provide proper fall and uniform bearing and support for each section of the pipe on undisturbed soil or 2" of sand fill at every point along its entire length, except for portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints. Bell holes shall be dug after the trench bottom has been graded. Where inverts are not shown, grading shall be determined by the National Plumbing Code for the service intended and the size used. Bell holes for lead pipe joints shall be 12" in depth below the trench bottom and shall extend from a point 6" back of the face of the bell. Such bell holes shall be of sufficient width to provide ample room for caulking. Bell holes for sewer tile and water pipe shall be excavated only to an extent sufficient to permit accurate work in the making of the joints and to insure that the pipe, for a maximum of its length, will rest upon the prepared bottom of the trench. Depressions for joints other than bell-and-spigot shall be made in accordance with the recommendations of the joint manufacturer for the particular type of joint used. In general, grading for
electrical ductbanks and conduits shall be from building to manhole, and from a high point between manholes to each manhole. Special pipe beds shall be provided as specified hereinafter.

3. The lower 4" of the pipe trenches measuring from an overhead line set parallel to the grade line of the sewer shall be excavated only a few feet in advance to the pipe laying, by men especially skilled in this type of work. Where damage is likely to result from withdrawing sheeting, the sheeting shall be left in place. Except at locations where excavation of rock from the bottom of trenches is required, care shall be taken not to excavate below the depths required. Where rock excavation is required, the rock shall be excavated to a minimum overdepth of 6" below the trench depths specified. The overdepth rock excavation and all excess trench excavation shall be backfilled with sand. Whenever wet or otherwise unstable soil is incapable of properly supporting the pipe is encountered in the trench bottom, such soil shall be removed to a depth and for the trench lengths required, and then backfilled to trench bottom grade, as hereinafter specified, with sand.

4. All grading in the vicinity of excavation shall be controlled to prevent surface ground water from flowing into the excavations. Any water accumulated in the excavations shall be removed by pumping or other acceptable method. During excavation, material suitable for backfilling shall be stacked in an orderly manner a sufficient distance back from edges of trenches to avoid overloading and prevent slides or cave-ins. Material unsuitable for backfilling shall be wasted and removed from the job site as directed by the Construction Inspector.

5. All shoring and sheeting required to perform and protect the excavations and to safeguard employees and/or adjacent structures shall be provided.

6. All surplus materials removed in these trenching operations becomes the property of the contractor, and shall be disposed of at the expense of the contractor, at a legal disposal site, off of the campus.

B. Backfilling:

1. Trenches shall not be backfilled until all required tests are performed and until the piping, utilities systems, etc., as installed are certified by the Owner's inspector to conform to the requirements specified hereinafter. The trenches shall be carefully backfilled with sand to a depth of 12 inches above the top of the pipe. The next layer and subsequent layers of backfill may be excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials free from large clods of earth or stones larger than 1 1/2" in diameter, flooded until the pipe has cover of not less than one foot. The remainder of the backfill material shall then be thrown into the trenches, moistened, and tamped or flooded in one foot layers. Blasted rock, broken concrete or pavement, and large boulders shall not be used as backfill material. Any trenches improperly backfilled, or where settlement occurs, shall be reopened to the depth required for proper compaction, then refilled and mounded over, and smoothed off.

2. Backfill under concrete slabs-on-fill shall be as specified above, shall be gravel, or shall be other such materials more suitable for the application. Installation and compaction shall be as required for compatibility with adjacent materials.

C. Opening and Re-closing Pavement and Lawns: Where excavation requires the opening of existing walks, streets, drives, other existing pavement, or lawns, such surfaces shall be cut as required to install new lines and to make new connections to existing lines. The sizes of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new work is completed and the excavation has been backfilled and flooded, the area shall be patched, using materials to match those cut out.
patches shall thoroughly bond with the original surfaces and shall be level with them, and shall meet all the requirements established by the authorities having jurisdiction over such areas.

D. Excavation in Vicinity of Trees: All trees including low hanging limbs within the immediate area of construction shall be adequately protected to a height of at least 5 ft. to prevent damage from the construction operations and/or equipment. All excavation within the outermost limb radius of all trees shall be accomplished with extreme care. All roots located within this outermost limb radius shall be brought to the attention of the Construction Inspector before they are cut or damaged in any way. The Construction Inspector will give immediate instructions for the disposition of same. All stumps and roots encountered in the excavation, which are not within the outermost limb radius of existing trees, shall be cut back to a distance of not less than 18" from the outside of any concrete structure or pipeline. No chips, parts of stumps, or loose rock shall be left in the excavation. Where stumps and roots have been cut out of the excavation, clean compacted dry bank sand shall be backfilled and tamped.

1.28 EXISTING FACILITIES:

A. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and in service maintenance of all plumbing, heating, air conditioning, and ventilating services for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.

B. The Contractor shall provide temporary or new services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.

C. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, conduit, outlet boxes, wiring, light fixtures, air conditioning ductwork and equipment, etc., to provide this access and shall reinstall same upon completion of work in the areas affected.

D. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed, all Contractors shall remove and reinstall in locations approved by the Architect/Engineer all devices required for the operation of the various systems installed in the existing construction. This is to include but is not limited to temperature controls system devices, electrical switches, relays, fixtures, piping, conduit, etc.

E. Outages of services as required by the new installation will be permitted but only at a time approved by the Owner. The Contractor shall allow the Owner two weeks in order to schedule required outages. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner. All costs of outages, including overtime charges, shall be included in the contract amount.

1.29 CHECKING AND TESTING MATERIALS AND/OR EQUIPMENT:

A. Before the work is accepted, an authorized representative of the manufacturer of the installed materials and/or equipment shall personally inspect the installation and operation of his materials and/or equipment to determine that it is properly installed and in proper operating order. The qualifications of the representative shall be appropriate to
the technical requirements of the installation. The qualifications of the representative shall be submitted to the owner for approval. The decision of the owner concerning the appropriateness of the representative shall be final. Testing and checking shall be accomplished during the course of the work where required by work being concealed, and at the completion of the work otherwise. In addition, the Contractor shall submit to the Architect/Engineer a signed statement from each representative certifying as follows: “I certify that the materials and/or equipment listed below have been personally inspected by the undersigned authorized manufacturer's representative and is properly installed and operating in accordance with the manufacturer's recommendations”.

B. Check inspections shall include plumbing equipment, heating, air conditioning, insulation, ventilating equipment, controls, mechanical equipment and such other items hereinafter specified or specifically designated by the Architect/Engineer.

1.30 TESTS:

A. The Contractor shall make, at no additional cost to the Owner, any tests deemed necessary by the inspection departments having jurisdiction, and in the National Fire Protection Association, ASTM, etc. Standards listed. The Contractor shall provide all equipment, materials, and labor for making such tests. Reasonable amounts of fuel and electrical energy costs for system tests will be paid by the Owner. Fuel and electrical energy costs for system adjustment and tests which follow beneficial occupancy by the Owner will be borne by the Owner.

B. Additional tests specified hereinafter under the various Specification Sections shall be made.

C. The Construction Inspector shall be notified in writing at least 10 working days prior to each test and other Specification requirements requiring action on the part of the Construction Inspector. All equipment shall be placed in operation and tested for proper automatic control requirements before the balancing agency starts their work.

D. Maintain Log of Tests as hereinafter specified.

E. See Specifications hereinafter for additional tests and requirements.

1.31 LOG OF TESTS:

A. All tests shall have pertinent data logged by the Contractor at the time of testing. Data shall include date, time, personnel, description, and extent of system tested, test conditions, test results, specified results, and other pertinent data. All Test Log entries shall be legibly signed by the Project Contractor or his authorized job superintendent.

1.32 COOPERATION AND CLEANUP:

A. It shall be the responsibility of each trade to cooperate fully with the other trades on the job to help keep the job site in a clean and safe condition. At the end of each day's work, each trade shall properly store all of his tools, equipment and materials and shall clean his debris from the job. Upon the completion of the job, each trade shall immediately remove all of his tools, equipment, any surplus materials and all debris caused by that portion of the work.
1.33 CLEANING AND PAINTING:

A. All equipment, piping, conduit, ductwork, grilles, insulation, etc., furnished and installed in exposed areas under Divisions 23 and 26 of these Specifications and as hereinafter specified shall be cleaned, prepared, and painted according to the following specification. In the event of a conflict between the specifications referenced, the provisions of this specification shall prevail only for Division 23 and Division 26 work.

B. All purchased equipment furnished by the mechanical and electrical subcontractors shall be delivered to the job with a suitable factory protective finish with the colors hereinafter specified. The following materials shall not be painted: copper, galvanized metal, stainless steel, fiberglass, PVC, and PVDF.

C. Before painting, materials and equipment surfaces shall be thoroughly cleaned of cement, plaster, and other foreign materials, and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Exposed metal work shall be carefully brushed down with the steel brushes to remove rust and other spots and left smooth and clean.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>COLOR</th>
<th>&quot;P and L&quot; PAINT NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment and Piping</td>
<td>Primer- Rust Inhibitive Metal Primer</td>
<td>Red Oxide</td>
</tr>
</tbody>
</table>

D. Jacketing on insulation shall not be painted.

E. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent their being rendered illegible due to the painting operation.

F. Scope of painting for Divisions 23 and 26 work in areas other than those defined as "exposed" is as follows:

1. All uncovered steel pipe, supports, exposed pipe and hanger rod threads shall be cleaned and painted with two coats of Tropical Paint Co. No. 77-black asphaltic emulsion. Galvanized steel and copper lines in these spaces shall not be painted.

2. All canvas finishes including those in concealed spaces shall be painted with one sizing coat if not already sized, containing mildew resistant additive and Arabol adhesive prior to any other specified finish paint.

3. All fuel piping (natural gas, LPG, etc.) shall be painted whether concealed or exposed, in all areas of the project without exception. Fuel piping shall be painted safety yellow. This "safety" color shall be as defined by OSHA.

4. If insulated, the piping shall be primed, only, prior to insulation, and the insulation jacketing shall be painted as specified for piping. The requirements of this paragraph are "primary" and have priority over any conflicting specification or instruction, should a conflict in the Construction Documents exist.

G. Additional areas to be defined as "exposed" for purposes of painting, are defined as follows: (Note that paragraph 1.04 of this Section defines exposed areas for the balance of the project. The areas listed below are to be painted in addition to exposed areas as previously defined.)

H. The surfaces to be finish painted shall first be prepared as follows:

1. On canvas finishes pretreat as specified above. Insulated surfaces having vapor barrier jacket exposed to view shall first be painted with one (1) coat of sealer.

2. Galvanized and black steel surfaces shall first be painted with one (1) coat of P&L galvanized metal primer. Primer may be eliminated on concealed fire and gas piping.
3. Aluminum surfaces shall first be painted with one (1) coat of P&L zinc chromate primer. (See Section 1.51.5)
4. Cast iron pipe shall first be primed with a "non-bleed" primer.
5. The underside of all cast iron sinks not recessed in a cabinet are included as items to be painted in exposed areas.

I. Electrical switchgear, disconnect switches, contactors, etc., with suitable factory applied finishes shall not be repainted; except for aesthetic reasons where located in finished areas as directed by the Architect/Engineer and in a color selected by the Architect/Engineer. Where factory applied finishes are damaged in transit, storage or installation, or before final acceptance, they shall be restored to factory fresh condition by competent refinishers using the spray process.

PART 2 - PRODUCTS

2.01 NOT USED.

PART 3 - EXECUTION

3.01 PIPE PRESSURE TESTS:

A. The following lines shall be tested at the stated pressure for the length of time noted:

<table>
<thead>
<tr>
<th>Testing</th>
<th>Testing</th>
<th>Pressure</th>
<th>Time in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Water</td>
<td>Water</td>
<td>150</td>
<td>24</td>
</tr>
</tbody>
</table>

B. Where leaks occur, the pipe shall be repaired and the tests repeated. No leaks shall be corrected by peening. Defective piping and joints shall be removed and replaced.

END OF SECTION 230000
SECTION 23 04 10 – ELECTRONIC VARIABLE SPEED DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, Supplementary General Conditions, all applicable requirements of Division 1, "General Requirements", and Section 230000, "Basic Mechanical Requirements", govern this Section.

1.2 DESCRIPTION OF WORK:
A. Work Included: The extent of electronic variable speed drive (VSD) work is as scheduled, shown on the Drawings, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications.
B. Types: The types of electronic variable speed drives required for the project include, but are not limited to variable frequency motor speed controllers.

1.3 STANDARDS:
A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards, as applicable:
   1. NEMA ICS 2 Industrial Control Devices, Controllers and Assemblies.
   2. NEMA KS 1 Enclosed Switches.
B. Each VSD shall comply with the applicable requirements of the latest standards of ANSI and IEEE-519-1981 5% voltage distortion and line notching category. Computations or computer simulations shall be provided with the submittals to confirm compliance. The VSD manufacturer shall supply all necessary items to comply.
C. VSD design and construction shall comply with all applicable provisions of the National Electric Code.

1.4 QUALITY ASSURANCE:
A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
   1. ABB.
   2. Toshiba.
   3. Yaskawa.
B. Products supplied under this section must be of domestic (USA) origin and manufacture.
C. UL Standards: Speed Controllers shall conform to all applicable UL Standards and shall be UL-listed.
D. Factory Testing: To ensure quality, each VSD shall be subjected to the following factory tests:
   1. The integrated circuits shall undergo a 120 hour "burn-in" to test reliability. During the "burn-in" the temperature shall be cycled between 0 and 70°C.
   2. The completed unit shall undergo a fully loaded 24 hour "burn-in" while serving a varying induction motor load. Test load shall vary between 50% and 100% of rated HP capacity and shall include a minimum of 12 hours at rated HP.
   3. The unit shall be subject to a series of in-plant quality controlled inspections before approval for shipment from manufacturer's facilities.
1.5 SUBMITTALS:

A. Shop drawing submittals shall include, but not be limited to, the following:

1. Cut sheets of individual speed controllers with construction, dimensions, weights, ratings, voltage, poles, options, and all associated accessories clearly indicated.

2. Wiring diagrams for the drive power, bypass, and control sections.

3. A detailed description of drive operation and adjustable parameters.

4. A detailed description of factory testing.

5. Additional information as required in Section 23 01 00.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Store speed controllers in a clean, dry space. Maintain factory-wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle speed controllers carefully to avoid damage to material components, enclosure and finish.

PART 2 - PRODUCTS

2.1 ELECTRONIC VARIABLE SPEED DRIVES:

A. General: Provide electronic variable speed drives for control of standard or high-efficiency NEMA Design B induction motors on air handling units where specified herein, scheduled, or shown on the Drawings.

B. Operation: Each variable speed drive shall convert available utility power to adjustable voltage/frequency, 3-phase, ac power for stepless motor control from 25 to 110% of motor 60 Hz speed.

1. The variable speed drive (VSD) shall produce an adjustable ac voltage/frequency output for complete motor speed control. Speed control shall be stepless throughout the range under a variable torque load on a continuous basis. The VSD shall be automatically controlled by an external control signal.

2. The VSD maximum output current rating shall be greater than or equal to the motor nameplate full load. The input power factor of the controller shall be 0.95 or greater under all speed and load conditions and the unit shall be rated for 100% operation at full rated current, voltage and frequency.

3. The VSD shall contain a fused input power disconnect or circuit breaker with door interlock.

C. Components: Each controller shall include, but not be limited to an input rectifier, constant voltage dc link, filter, sine-weighted pulse width modulation inverter and accessory sections with each section modularized for ease of troubleshooting. Controller shall be protected with I2T fuses or circuit breakers per the manufacturer's design and specification. All components shall be factory mounted and wired on a dead-front, grounded, free-standing or wall-mounted minimum NEMA 1 enclosure arranged for top or bottom conduit entry. The free-standing enclosure shall be suitable for mounting on a steel platform or on a concrete housekeeping pad.

1. The controller enclosure shall be provided with the manufacturer's illustrated operating instructions and parts list mounted inside the enclosure door, manual speed control potentiometer, three position mode selector switch (manual-off-auto), "power on" light, diagnostic/frequency display, auxiliary relays, and contacts for interlock and control wiring.
D. **Features:** VSD features shall include, but not be limited to, the following:

1. **Input Power:** 230 volts ac _10%, 60 Hz, _1.8 Hz. Input power factor shall be 0.95 or greater from full motor speed to zero speed for any motor load.

2. **Output Power:** single phase, 0-230 volts, 2-60 Hz.

3. **Ambient Temperatures:** Operating: 0°C to 40°C (32°F to 104°F). Storage: -20°C to 60°C (-4°F to 140°F).

4. **Frequency Stability:** Output frequency will be held to _0.1% of maximum frequency regardless of load, _10% input voltage change or temperature changes within the ambient specification.

5. **Disconnect:** Locking type input disconnect switch with external operating handle.

6. **Bypass:** Manual bypass which isolates the drive from the circuit and allows motor operation at full across-the-line speed. Bypass shall include motor contactor, drive isolation contactors, motor overload protection, fused control power transformer and front panel mounted bypass controls.

7. **Input Filter:** Input line filter capable of protecting the electronics against transient voltage spikes or notches.

8. **Current Limit:** To limit output current to 110% of that of the drive rating. The current limit shall be designed to function automatically to prevent overcurrent trip due to momentary overload conditions, allowing the drive to continue operation.

9. **Instantaneous Overcurrent Trip:** To safely limit the output current in under 50 microseconds due to short circuit or severe overload conditions.

10. **Undervoltage Trip:** To protect the drive due to non-momentary power or phase loss. The undervoltage trip will activate automatically when line voltage drops 15% below rated input voltage.

11. **Overvoltage Trip:** To protect the drive due to voltage levels in excess of its rating. The overvoltage trip will activate automatically when the inverter bus in the controller exceeds 950 volts dc.

12. **Ground Fault Protection:** Fuseless electronic power protection for ground fault protection. Isolation transformers for ground fault protection are not acceptable. Ground fault shall not cause fuses to open.

13. **Overload Protection:** Electronic output overload protection shall be provided to eliminate the use of bimetallic overloads. The drive shall not be phase sequence sensitive. The overload protection shall also protect the motor when it is operated at full speed in the bypass mode.

14. **Overtemperature Trip:** To protect the drive from elevated temperatures in excess of its rating. An indicating light which begins flashing with 10°C of the trip point will be provided to alert the operator to the increasing temperature condition. When the overtemperature trip point is reached, this light will be continuously illuminated.

15. **Automatic Reset/Restart:** The drive shall be equipped such that a trip condition resulting from overcurrent, undervoltage, overvoltage or overtemperature shall be automatically reset, and the drive shall automatically restart upon removal, or correction of the causative condition. The number of reset/restart attempts for undervoltage, overvoltage, overtemperature and overcurrent shall be limited to five. If, in five attempts, a reset/restart is not successful, the drive shall shut down safely, requiring a manual restart. If, within five attempts, a successful reset/restart occurs, the Auto Reset/ Restart circuit will reset the attempts counted to zero after approximately 10 minutes of continuous operation.
16. **Power Interruption:** In the event that an input or output power contactor is opened or closed while the drive is activated, no damage to the drive shall result.

17. **Short Circuit Protection:** In the event of a phase-to-phase short circuit the drive shall be designed to shut down safely without component failure.

18. **Sustained Power Loss:** In the event of a sustained power loss, the drive shall be designed to shut down safely without component failure. Upon return of power, the system shall be designed to automatically return to normal operation.

19. **Momentary Power Loss:** In the event of a momentary power loss, the drive shall be designed to ride-through a power interruption up to five cycles and shut down safely without component failure. Upon a more extended momentary power loss, the system shall be designed to automatically return to normal operation upon return of power.

20. **Stand Alone Operation:** To facilitate start-up troubleshooting, the drive shall be designed to operate without a motor or any other equipment connected to the drive output.

21. **Start/Stop Control:** The drive may be started or stopped by any one of the following:
   a. A contact closure rated 50 ma, 115 volt ac minimum.
   b. Use of a motor starter or contactor in the input power line.
   c. The speed control signal dropping below or rising above minimum.
   d. An external 115 volt ac signal.
   e. Operation of momentary start/stop switch or pushbuttons. The drive shall include built-in holding contacts for this purpose.

22. **Speed Control:** The drive will adjust the output frequency in proportion to a [0-5 volt dc Analog] [0-10 volt dc Analog] [4-20 ma dc Analog] [3-15 psig Pneumatic] [135 Ohm Potentiometer] [5000 Ohm Potentiometer] input.

23. **Minimum and Maximum Speed Control:** Adjustable minimum and maximum speed potentiometers for all speed signals. Minimum range shall be 0-80%, field set at 40%. Maximum range shall be 100-0%, field set at 100%.

24. **Signal Gain and Offset:** Adjustable signal gain (1:1 to 10:1 range) and offset (0-50% of input signal for all speed signals.

25. **Inverted Signal:** Inverted speed signal selector switch to invert the response to input speed signal.

26. **Automatic Reversing:** Reversing terminals to automatically reverse the rotation of the motor(s) shall be available for customer use if so desired. When a contact closure is made across these terminals, the motor shall decelerate from its operating speed to zero at the preset deceleration rate. Upon reaching zero, it shall reverse direction and accelerate to the set speed at the present acceleration rate.

27. **Adjustable Accel/Decel:** Independently adjustable acceleration and deceleration time potentiometers from 30-300 seconds, field set at 90 seconds.

28. **Control Isolation:** Low voltage logic and 115 volt control circuits shall be electrically isolated from the power circuits. Signal circuit common shall be grounded.

29. **Control Adjustments:** All control adjustments shall be made without the necessity of an extender board or specialized meters, and from front accessible controls.
30. **Diagnostics**: A diagnostic fault detection center shall be integral to each VSD, providing an indication of the following fault conditions:
   a. External fault.
   b. Processor line fault.
   c. Low ac line voltage.
   d. High ac line voltage.
   e. Current overload.
   f. High dc bus voltage.
   g. VSD output fault.

31. **Status Lights**: Status lights for indications of conditions described in Items 1 through 5 shall be provided. An SPDT contact for remote indication of Items 2 through 5 shall be provided. Additionally, status lights to show "Power On", "Zero Speed", and "Drive Enabled" shall be provided. All status lights shall be self-contained in the front panel of the unit and shall be duplicated for ease of troubleshooting on the inside of the unit. Status lights shall be red, light-emitting diode type for high visibility and reliability.

32. **Indicating Lights**:
   a. **Power On**: Lights any time input power is applied to the drive.
   b. **Zero Speed**: Illuminates whenever the drive is at zero frequency.
   c. **Enabled**: Lights to indicate that the drive has a start command.
   d. **Over Temperature**: Begins flashing when the internal temperature of the drive is within 10°C of overheating. Upon reaching the overtemperature trip point, the light is continuously illuminated.
   e. **Current Limit**: Indicates that the Accel, Decel or Run Limit circuit is in operation.
   f. **Undervoltage**: Indicates that an undervoltage trip has occurred.
   g. **Overvoltage**: Indicates that an overvoltage trip has occurred.
   h. **Overcurrent**: Indicates that the current rating of the drive has been exceeded and the overcurrent trip circuit has been activated.

33. **External Alarm Contacts**: A single pole, double throw contact rated 115 volt ac, 28 volt dc, 1 amp resistive, shall be available for external monitoring. Contact will change state when any trip condition has occurred.

34. **Speed Reference Signal**: A 0 to 5 volt dc signal shall be provided for customer use. This 0 to 5 volt dc signal shall vary in direct proportion to the drive speed.

35. **User Interface**: The VSD shall have the following door mounted user interface devices:
   b. Hand/Off/Auto (or equivalent) selector switch.
   d. Digital Readout Frequency Meter/Diagnostic Display.
E. System Operation:

1. Selector switch in the "off" position - the controller run circuit will be open and the system will not operate.
2. Selector switch in the "manual" position - the speeds of the motor will be controlled by the manual speed potentiometer.
3. Selector switch in the "auto" position - operation will be via the external control input signal with the output speed proportional to the input signal.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRONIC VARIABLE SPEED DRIVES:

A. General: Install electronic variable speed drives where shown, in accordance with the manufacturer’s written instructions, the applicable requirements of the NEC and the NECA’s “Standard of Installation”, and recognized industry practices to ensure that products serve the intended function.

B. Supports: Provide all electronic variable speed drives with galvanized angle or other suitable supports where mounting on wall or other rigid surface is impractical. Drives shall not be supported by conduit alone. Where drives are mounted on equipment served, the drive shall not inhibit removal of any service panels or interfere with any required access areas. All drives shall be installed plumb and aligned in the plane of the wall in/on which they are installed.

C. Coordination: The Division 23 Contractor shall coordinate electronic variable speed drive selection and installation including, but not limited to, the following:

1. Coordinate power wiring to electronic variable speed drives and served motors with the Division 26 Contractor.
2. Coordinate selection of variable speed drives and served motors to insure compatibility.

3.2 START-UP/TESTING:

A. Pre-energization Check: The Division 26 Contractor shall check electronic variable speed drive power wiring for continuity of circuits and for short circuits.

B. Start-up Services: A representative of the variable speed drive manufacturer shall provide start-up services for each drive including, but not limited to, the following:

1. Check out of drive control and power wiring.
2. Start-up drive and demonstrate proper manual, automatic, and bypass operation.
3. Adjust variable speed drive overload protection and other adjustable parameters to suit project requirements.

C. Motor/Controller Coordination Documentation: Provide motor/controller coordination documents including, but not limited to, the following information in the operation and maintenance manuals.

1. Motor size in horsepower.
5. Size and manufacturer’s catalog number of electronic variable speed drives.
6. Setting of electronic variable speed drive overload protection and other adjustable parameters.
D. **Motor Rotation**: Verify that motor rotation is correct as connected. Where rotation must be changed, the Division 26 Contractor shall reconnect phase conductors to motor leads at motor junction box.

### 3.3 TRAINING:

A. **General**: A representative of the variable speed drive manufacturers shall provide for and present to the Owner, at no cost, a training and troubleshooting course at the owner's location. This course shall be comprised of 2 days of classroom instruction for 4 hours per day complete with visual aids, documentation, circuit diagrams and hands-on training. This course is not to be construed as a sales meeting, but rather as a school to familiarize the owner with the care, troubleshooting, and servicing of the variable speed drives. The manufacturer's representative shall provide a list of recommended spare parts.

### 3.4 IDENTIFICATION:

A. Refer to Section 23 03 00 for painting and nameplate requirements for all electronic variable speed drives.

B. Each electronic variable speed drive shall have an internal wiring diagram on the inside of the drive cover and shall be labeled inside the cover to indicate the type, ampacity and horsepower rating of the unit.

**END OF SECTION 23 04 10**
SECTION 230513

MOTORS

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, Supplementary General Conditions, all applicable requirements of Division 1, "General Requirements", and Section 230000, "Basic Mechanical Requirements", govern this Section.

B. Section 230000 – Basic Mechanical Requirements

C. Section 230529 – Sleeves, Flashings, Supports and Anchors

D. Section 230553 – Mechanical Identification

1.2 SECTION INCLUDES

A. Single phase electric motors

B. The Contractor shall provide all motors required for equipment supplied under this Division of the work

1.3 RELATED WORK

A. Section 221500 - Plumbing Equipment: Plumbing pumps

1.4 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings

B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings

C. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators

D. ANSI/NEMA MG 1 - Motors and Generators

E. ANSI/NFPA 70 - National Electrical Code

1.5 SUBMITTALS

A. Provide product data under provisions of Section 230000

B. Provide test results verifying nominal efficiency and power factor for motors 1 horsepower and larger.

C. Provide manufacturer’s installation instructions under provisions of Section 230000

1.6 OPERATION AND MAINTENANCE DATA

A. Provide operation and maintenance data under provisions of Section 230000

B. Provide assembly drawings, bearing data including replacement sizes, and lubrication instructions.
1.7 QUALIFICATIONS
   A. Manufacturer: Company specializing in manufacture of electric motors for commercial use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience. No Baldor motors will be accepted.

1.8 REGULATORY REQUIREMENTS
   A. Conform to ANSI/NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING
   A. Deliver products to site under provisions of Section 230000.
   B. Store and protect products under provisions of Section 230000.
   C. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.10 WARRANTY
   A. Provide five year manufacturer's warranty under provisions of Section 230000.
   B. Warranty: Include coverage for motors 1 horsepower and larger.

PART 2 - PRODUCTS

2.1 GENERAL CONSTRUCTION AND REQUIREMENTS
   A. Electrical Service: Refer to Drawing Schedules for required electrical characteristics.
   B. All Motors: Design for continuous operation in 40 degrees C environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, Service Factor, and motor enclosure type.
   C. Totally Enclosed Motors: Design for a service factor of 1.00 and an 80 degrees C maximum temperature rise in the same conditions.
   D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, Service Factor, Power Factor, efficiency.
   E. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.
   F. Motors shall be built in accordance with the latest ANSI, IEEE, and NEMA Standards, and shall be fully coordinated with the equipment served, shall be of sizes and electrical characteristics scheduled, and of approved manufacture as described herein or of the same manufacture as the equipment which they serve. All motors provided by the Contractor shall be of the same manufacture unless they are an integral part of the piece of equipment to which they are attached. Nameplate rating of motors shall match the characteristics scheduled.
   G. All motors shall be designed for NEMA Design B starting torque unless the driven machine requires high starting torque and shall be selected for quiet operation, free from magnetic hum.
H. In addition, all motors shall be provided with adequately sized electrical connection box with threaded hub for attachment of flexible conduit, unless bus duct connection is indicated. Where motors are connected to driven equipment by the use of a V-belt drive, they shall be furnished with adjustable rails.

I. All motors shall be provided with all copper windings, terminal wiring, and copper or bronze lugs. AL/CU rated connectors are not allowed.

2.2 SINGLE PHASE POWER - SPLIT PHASE MOTORS
A. Starting Torque: Less than 150 percent of full load torque.
B. Starting Current: Up to seven times full load current.
C. Breakdown Torque: Approximately 200 percent of full load torque.
D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, pre-lubricated sleeve or ball bearings.
E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.
F. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors with drip-proof enclosures except as hereinafter specified. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.3 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS
A. Starting Torque: Exceeding one fourth of full load torque.
B. Starting Current: Up to six times full load current.
C. Multiple Speed: Through tapped windings.
D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, pre-lubricated sleeve or ball bearings, automatic reset overload protector.
E. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.4 SINGLE PHASE POWER - CAPACITOR START MOTORS
A. Starting Torque: Three times full load torque.
B. Starting Current: Less than five times full load current.
C. Pull-up Torque: Up to 350 percent of full load torque.
D. Breakdown Torque: Approximately 250 percent of full load torque.
E. Motors: Capacitor in series with starting winding; capacitor-start/capacitor-run motors shall have two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
F. Enclosures shall be of the open drip-proof type with a service factor of 1.15 and Class B insulation rated at 90 degrees C temperature rise measured above 40 degrees C room ambient condition at full load, unless otherwise noted.
G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

H. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.5 STARTING EQUIPMENT:

A. Each motor shall be provided with proper starting equipment. This equipment, unless hereinafter specified or scheduled to the contrary, shall be provided by the trade furnishing the motor. All motor starting equipment provided by any one trade shall be of the same manufacture unless such starting equipment is an integral part of the equipment on which the motor is mounted. The Mechanical Subcontractor shall furnish all starters for Division 23 work, except those starters scheduled to be provided in Division 26 Motor Control Centers.

B. Motor starters shall conform to NEMA Standards for Industrial Control, #IC-1, latest issue, and shall be housed in NEMA Standard enclosures. Control voltage in each starter shall be not more than 120 volts to ground, with an individual control transformer provided in each starter as required. Manual starters for fractional horsepower single-phase motors shall be on-off or snap switch type combined with thermal overload device. The switch shall be so constructed so that it cannot be held closed under a sustained motor overload.

C. Magnetic starters shall have thermal overload protection in each of the ungrounded legs and shall be solenoid operated. Provide the correct size heater element to protect the motor and allow it to operate based on motor nameplate amperes and ambient temperatures anticipated for each individual motor. Each starter shall be provided with a control power transformer or 120v control power circuit.

D. Pushbuttons with or without pilot lights, hand-off-automatic switches and other scheduled apparatus shall be standard duty type mounted in NEMA enclosures or in cover of starter as specified or scheduled, and shall be furnished by the trade furnishing the starter except as specifically indicated elsewhere.

E. Hand-Off-Automatic switches for equipment which could damage itself if left in the "hand" position (such as sump pumps), shall be spring return to "off" from the "hand" position.

PART 3 - EXECUTION

3.01 APPLICATION

A. Motors drawing less than 250 Watts and intended for intermittent service may be germane to equipment manufacturer and need not conform to these specifications.

B. Motors shall be open drip-proof type, except where specifically noted otherwise.

C. Motors shall be energy efficient type.

D. Single phase motors for shaft mounted fans or blowers shall be permanent split capacitor type.

E. Motors for air-cooled condensers shall be totally enclosed type.

F. Motors located in exterior locations shall be totally enclosed weatherproof epoxy-treated type.
### NEMA OPEN MOTOR SERVICE FACTORS

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### 3.02 MOTOR EFFICIENCIES – NOMINAL, FULL LOAD, THREE PHASE

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END OF SECTION 230513
SECTION 230529
SLEEVES, Flashings, Supports and Anchors

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General
   Conditions, Supplementary General Conditions, all applicable requirements of Division 1,
   “General Requirements”, and Section 230000, “Basic Mechanical Requirements”, govern
   this Section.

B. Section 230000 – Basic Mechanical Requirements

C. Section 230553 – Mechanical Identification

1.2 SECTION INCLUDES

A. Pipe and equipment hangers and supports

B. Equipment bases and supports

C. Sleeves and seals

D. Flashing and sealing equipment and pipe stacks

1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Placement of inserts in concrete formwork.

B. Placement of roofing pipe and supports.

C. Placement of equipment roof supports.

D. Placement of roof sleeves, vents, and curbs.

1.4 RELATED SECTIONS

A. Section 033000 - Cast-In-Place Concrete: Equipment bases

B. Section 230719 - Piping Insulation

C. Section 221000 - Plumbing Piping

1.5 REFERENCES

A. ASME B31.1 - Power Piping

B. ASME B31.2 - Fuel Gas Piping

C. ASME B31.5 - Refrigeration Piping

D. ASME B31.9 - Building Services Piping

E. ASTM F708 - Design and Installation of Rigid Pipe Hangers

F. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer

G. MSS SP69 - Pipe Hangers and Supports - Selection and Application

H. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices
1.6 SUBMITTALS

A. Submit under provisions of Section 230000.
B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
C. Product Data: Provide manufacturers catalog data including load capacity.
D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
E. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.7 REGULATORY REQUIREMENTS

A. Conform to applicable code for support of plumbing and hydronic piping.

PART 2 - PRODUCTS

2.1 HANGERS AND SUPPORTS

A. Manufacturers:
   1. Grinnell.
   2. Kindorf
   3. B-Line
   4. Power Strut
   5. Other acceptable manufacturers offering equivalent products.

B. Supports, hangers, anchors and guides shall be provided for all horizontal and vertical piping. Shop Drawings shall be provided, indicating locations and details of anchors, guides, expansion loops and joints, hangers, etc. The hanger design shall conform to the ASME Code for Pressure Piping.

C. All auxiliary steel required for supports, anchors, guides, etc. shall be provided by the Mechanical Trades unless specifically indicated to be provided by others.

D. The supports, hangers, anchors, and guides for the chilled water supply and return piping, steam piping, condensate return piping, etc. of the Campus Loop System routed through utility tunnels and below buildings shall be provided as indicated on the Drawings.

E. Contractor shall review all Drawings, including Structural Drawings, for details regarding pipe supports, anchors, hangers, and guides.

F. All Supports shall be of type and arrangement to prevent excessive deflection, to avoid excessive bending stresses between supports, and to eliminate transmission of vibration.

G. All rod sizes indicated in this Specification are minimum sizes only. This trade shall be responsible for structural integrity of all supports, anchors, guides, etc. All structural hanging materials shall have a minimum safety factor of 5 built in.

H. Anchor points as indicated on Drawings or as required shall be located and constructed to permit the piping system to take up its expansion and contraction freely in opposite directions away from the anchored points.

I. Guide points shall be located and constructed wherever required or indicated on Drawings and at each side of an expansion joint or loop, to permit free axial movement only.
J. Supports, hangers, anchors, and guides shall be fastened to the structure only at such points where the structure is capable of restraining the forces in the piping system.

K. Hangers supporting and contacting brass or copper lines 3” in size and smaller shall be Grinnell Fig. CT-99c, adjustable, copper plated, tubing ring. Hangers supporting and contacting brass or copper lines 4” and larger shall be Grinnell Fig. 260, adjustable clevis, with a nut above and below the hanger, and approved neoprene isolating material between pipe (or tubing) and hanger on the support rod. For insulated copper or brass domestic water lines, hangers for all sizes of pipe shall be Grinnell Fig. 300, adjustable clevis, with a nut above and below the hanger, and approved neoprene isolating material between pipe (or tubing) and hanger on the support rod. Isolate all copper or brass lines from all ferrous materials with approved dielectric materials. Hangers supporting and contacting plastic or glass piping shall be of equal design, but shall be padded with neoprene material or equal. The padding material and the configuration of its installation shall be submitted for approval.

L. Hangers supporting insulated lines where the outside diameter of the insulation is the equivalent of 8” diameter pipe or smaller in size and supporting all ferrous lines 6” and smaller in size shall be Grinnell Fig. 260, adjustable clevis, with a nut above and below the hanger on the support rod.

M. Hangers supporting and contacting ferrous lines larger than 6” in size and outside of insulation on lines with the outside diameter equivalent to 10” diameter pipe shall be Grinnell Fig. 260, adjustable clevis, with a nut above and below the hanger on the support rod.

N. Other special type of hangers may be employed where so specified or indicated on the Drawings, or where required by the particular conditions. In any case, all hangers must be acceptable to the owner.

O. Each hanger shall be properly sized to fit the supported pipe or fit the outside of the insulation on lines where specified. Hangers for dual or low temperature insulation pipes shall bear on the outside of the insulation, which shall be protected by support shields as specified in Section 230719 - PIPING INSULATION. Protect insulation from crushing by means of a section of rigid insulation to be installed at hanger points. Hangers for high temperature insulated pipes and all insulated hot and cold domestic water pipes shall be encased in the insulation unless supported by trapezes in which case shield and rigid insulation shall be provided as specified above for low temperature insulated pipes.

P. Supports for vertical piping in concealed areas shall be double bolt riser clamps, Grinnell Fig. 261, or other approved equal, with each end having equal bearing on the building structure, and located at each floor. Two-hole rigid pipe clamps at 4 ft. o.c. or Kindorf channels and Grinnell Fig. 261 riser clamps may be used to support pipe directly from vertical surfaces or members where lines are not subject to expansion and contraction. When piping is subject to expansion and contraction, provide spring isolators. Where brass or copper lines are supported on trapeze hangers or Kindorf channels the pipes shall be isolated from these supports with plastic tape with insulating qualities, or strut clamps as manufactured by Specialty Products Company, Stanton, California.

Q. Supports for vertical piping in exposed areas (such as fire protection standpipe in stairwells) shall be attached to the underside of the building structure above the top of the riser, and the underside of the penetrated structure. The contractor shall use a drilled anchor as specified above, and use a Grinnell No. 595 Socket Clamp with Grinnell No. 594 Socket Clamp Washers, as a riser clamp. The top riser hanger shall consist of two (2) hanger rods (sized as specified) anchored to the underside of the building structure,
supporting the pipe by means of the material specified. Risers penetrating floors shall be supported from the underside of the penetrated floor as specified for the top of the riser.

R. Pipe Supports in Chases and Partitions: Horizontal and vertical piping in chases and partitions shall be supported by hangers or other suitable support. Pipes serving plumbing fixtures and equipment shall be securely supported near the point where pipes penetrate the finish wall. Supports shall be steel plate, angles, or special channels such as Unistrut mounted in vertical or horizontal position. Pipe clamps such as Unistrut P2426, P2008, P1109 or other approved clamps shall be attached to supports. Supports shall be attached to wall or floor construction with clip angles, brackets, or other approved method. Supports may be attached to cast iron pipe with pipe clamp, or other approved method. All copper or brass lines shall be isolated from ferrous metals with dielectric materials to prevent electrolytic action.

S. All electrical conduits shall be run parallel or perpendicular to adjacent building lines. Single conduits running horizontally shall be supported by "Caddy" or "Mineralac" type hangers from adequately sized rods (minimum 1/4") from the building structure. Where multiple conduits are run horizontally, they shall be supported on trapeze of "Unistrut" type channel suspended on rods or bolted to vertical building members. Conduit shall be secured to channel with galvanized "Unistrut" type conduit clamps or stainless steel "Unistrut" type "Uni-Clips." All hangers shall be fastened to the building structure in the same manner as specified above for pipe hangers. Spacing of hangers shall be adequate for the weight and rigidity of the conduits involved; in any case, no greater than 8' centers, within 12" of each change of direction and on both sides of line valves. Where feasible, conduits may be fastened to the concrete by one-hole straps thoroughly anchored to the concrete in an approved manner. Flexible conduit shall also be supported in an acceptable manner so as not to interfere with the maintenance of above-ceiling equipment, and to support it from touching the ceiling system. Conduit shall be located so as not to inhibit removal of ceiling tiles.

T. Perforated strap iron or wire will not, under any circumstances, be acceptable as hanger material.

U. Vibration Isolation: Resilient hangers shall be provided on all piping connected to rotating equipment (pumps, etc.). Piping or ductwork that may vibrate and create an audible noise shall also be isolated. Spring hangers or supports shall be provided where indicated on the Drawings.

V. Attachment:
1. The load and spacing on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including the concrete which holds the inserts. Reinforcement at inserts shall be provided as required to develop the strength required.

2. Inserts shall be of a type which will not interfere with reinforcing as shown on the structural Drawings and which will not displace excessive amounts of structural concrete.

3. All supports shall be designed and installed to avoid interference with other piping, hangers, ducts, electrical conduit, supports, building structures, equipment, etc. All piping shall be installed with due regard to expansion and contraction and the type of hanger method of support, location of support, etc. shall be governed in part by this Specification.

4. Hangers shall be attached to the structure as follows:
   a. Poured In Place Concrete: Where pipes and equipment are supported under poured in place concrete construction, each hanger rod shall be fitted with a nut at its upper end, which nut shall be set into an
Underwriters Laboratories, Inc. listed universal concrete insert placed in the form work before concrete is poured. Where inserts are placed in the bottom faces of concrete joists which are too narrow to provide adequate strength of concrete to hold the insert properly or where a larger insert would require displacement of the bottom joist steel, the hanger rod shall be suspended from the center of a horizontal angle iron, channel iron, I-beam, etc. spanning across two adjacent joists. The horizontal support shall be bolted to nonadjustable concrete inserts of the "spot" type, of physical size small enough to avoid the bottom joist steel.

b. Steel Bar Joists: Where pipes and loads are supported under bar joists, hanger rods may be run through the space between the bottom angles and secured with a washer and two nuts. Where larger lines are supported beneath bar joists, hanger rods shall be secured to angle irons of adequate size; each angle shall span across two or more joists as required to distribute the weight properly and shall be welded to the joists or otherwise permanently fixed thereto.

c. Steel Beams: Where pipes and loads are supported under steel beams, approved type beam clamps shall be used.

d. Wood Framing: Where pipes and loads are supported from wood framing, hanger rods shall be attached to framing with side beam brackets or angle clips.

e. Pre-Cast Tee Structural Concrete: Hanger supports, anchors, etc. required for mechanical systems attached to the precast, double tee, structural concrete system are to be installed in accord with approved shop Drawings only. Holes required for hanger rods shall be core drilled in the "flange" of the double tee only; impact type tools are not allowed under any circumstances. Core drilling in the "stem" portions of the double tee is not allowed. Holes core drilled through the "flange" for hanger rods shall be no greater than 1/4" larger than the diameter of the hanger rod. Hanger rods shall be supported by means of bearing plates of size and shape acceptable to the Architect/Engineer and Owner, with welded double nuts on the hanger rod above the bearing plate. Cinch anchors, lead shields, expansion bolts, and studs driven by explosion charges are not allowed under any circumstances in the lower 15" of each stem and in the "shadow" of the stem on the top side of the "double tees."

f. If it is necessary to install a method of fastening a hanger after the structure has been installed, then only clamps or drilled anchors shall be used.

g. Power-actuated fasteners (shooting) will not be acceptable under any circumstances.

h. Note: Under no circumstances will the use of plastic anchors or plastic expansion shields be permitted for any purpose whatsoever.

W. Trapezes: Where multiple lines are run horizontally at the same elevation and grade, they may be supported on trapezes of Kindorf, Uni-Strut, Power Strut, or approved equal, channel-suspended on rods or pipes. Trapeze members including suspension rods shall each be properly sized for the number, size, and loaded weight of the lines they are to support.

X. Finishes: All hangers on piping including clevis hangers, rods, inserts, clamps, stanchions, and brackets, shall be dipped in Zinc Chromate Primer before installation. Rods may be galvanized or cadmium plated after threading, in lieu of dipping zinc chromate. Universal concrete inserts shall be cadmium plated.
Y. Miscellaneous: Provide any other special foundations, hangers and supports indicated on the Drawings, specified elsewhere herein; or required by conditions at the site. Hangers and supporting structures for suspended equipment shall be provided as required to support the load from the building structure in a manner acceptable to the Architect/Engineer and Owner.

2.2 ACCESSORIES

A. Hanger Rods: Galvanized mild steel threaded both ends, galvanized threaded one end, or galvanized continuous threaded.

B. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods. Suitable concrete inserts for pipe and equipment hangers shall be set and properly located for all pipe and equipment to be suspended from concrete construction. If the inserts are later found not to be in the proper location for the placement of hangers, then drilled anchors shall be installed. Drilled anchors in concrete or masonry shall be submitted for the approval by the Owner.

2.3 FLASHING AND EQUIPMENT CURBS

A. Metal Flashing: 26 gauge galvanized (stainless steel) steel.

B. Metal Counterflashing: 22 gauge galvanized (stainless steel) steel.

C. Roofing Flashing: See specifications for Roofing, elsewhere in these Specifications.

D. Caps: Steel, 22 gauge minimum; 16 gauge at fire resistant elements.

E. Curbs: Welded 18 gauge galvanized steel shell and base, mitered 3 inch cant, variable step to match roof insulation, factory installed wood nailer.

2.4 HOUSEKEEPING PADS

A. Concrete foundations for the support of equipment such as floor mounted panels, pumps, fans, air handling units, etc., shall extend 6" on all sides beyond the limits of the mounted equipment unless otherwise noted and shall be poured in forms built of new dressed 4" nominal lumber. All corners of the foundations shall be neatly chamfered by means of sheet metal or triangular wood strips nailed to the form. Foundation bolts shall be placed in the forms when the concrete is poured, the bolts being correctly located by means of templates. Each bolt shall be set in a sleeve of size to provide 1/2" clearance around bolt. Allow 1" below the equipment bases for alignment and grouting. After grouting, the forms shall be removed and the surface of the foundations shall be hand rubbed with Carborundum. Foundations for equipment located on the exterior of the building shall be provided as indicated. Foundations shall be constructed in accordance with Shop Drawings submitted by the Contractor for review by the Architect/Engineer.
2.5 WALL, FLOOR AND CEILING PLATES:

A. Except as otherwise noted, provide C.P. (Chrome plated) brass floor and ceiling plates around all pipes, conduits, etc., passing exposed through walls, floors, or ceilings, in any spaces except underfloor and attic spaces. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines which are insulated and positively secured to such pipe or insulation. Plates will not be required for piping where pipe sleeves extend 3/4" above finished floor. All equipment rooms are classified as finished areas. Round and rectangular ducts shall have closure plates (NOT chrome plated) made to fit accurately at all floor, wall and ceiling penetrations. Floor penetrations in exposed (except in stair wells) areas shall be finished using 'bell' fitting to fit pipe or insulation and sleeve and shall be painted to match the pipe. Penetrations in stairwells shall have flat floor plate painted to match pipe.

2.6 SLEEVES

A. General: All openings through all floors, walls, and roofs, etc., regardless of material for the passage of piping, ductwork, conduit, cable trays, etc., shall be sleeved. All penetrations must pass through sleeves. Sleeves shall be set in new construction before concrete is poured, as cutting holes through any part of the concrete will not be permitted unless acceptable to the Architect/Engineer and Owner. If a penetration is cored into an existing vertical solid concrete, masonry or stone structure, then the installation of a sleeve will not be necessary.

1. Sleeve material for floors and exterior walls shall be Schedule 40 galvanized steel with welded water stop rings.
2. Sleeves through interior walls to be galvanized sheetmetal with gauge as required by wall fire rating, 20 gauge minimum.
3. Sleeves through load-bearing surfaces shall be constructed of uncoated carbon steel pipe.

B. The minimum clearance between horizontal penetrations including insulation where applicable, and sleeve shall be 1/4", except that the minimum clearance shall accommodate a Thunderline Link-seal closure where piping exits the building, or penetrates a wall below ground level. Contractor shall be responsible for the accurate location of penetrations in the slab for his pipe, duct, etc. All penetrations shall be of ample size to accommodate the pipe, duct, etc., plus any specified insulation. Void between sleeve and pipe in interior penetrations shall be filled with Nelson Flameseal Firestop or approved equal caulk or putty.

C. Floor sleeves shall extend above the finished floor as detailed on the drawings, except that floor sleeves in stairwells shall be flush with the finished floor. Sleeves in walls shall be trimmed flush with wall surface. Refer to the details on the project drawings. Where the details differ from these specifications, the drawings take precedence.

D. Sleeves for penetrations passing through walls or floors on or below grade shall be removed, if practical, and after the pipes have been installed, the void space around the pipe shall be caulked with a suitable material to effect a waterproof penetration. Note that the practicality of the removal of the sleeve shall be the decision of the Construction Inspector. The decision of the Inspector shall be final.

E. Sleeves shall not be installed in structural members unless specifically approved by the University.

F. Vermin proofing: The open space around all ductwork, piping, etc., passing through the ground floor and/or exterior walls shall be vermin proofed in a manner acceptable to the Owner.
G. Waterproofing: The annular space between a pipe and its sleeve in interior floors shall be filled with polyurethane foam rods 50 percent greater in diameter than the space as backing and fill material and made watertight with a permanent elastic polysulfide compound. Seal both surfaces of floor.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.02 INSERTS

A. Provide inserts for placement in concrete formwork.
B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.03 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as scheduled.
B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
C. Place hangers within 12 inches of each horizontal elbow.
D. Use hangers with 1-1/2 inch minimum vertical adjustment.
E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub. For pipe risers exceeding three floors, evaluate pipe supports for longitudinal expansion and support requirements. Support riser piping independently of connected horizontal piping.
G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
H. Support riser piping independently of connected horizontal piping.
I. Provide copper plated hangers and supports for copper piping.
J. Design hangers for pipe movement without disengagement of supported pipe.
K. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed, but shall be corrosion protected with galvanized plating. Repair any damaged galvanized plating with a coating of 'Galvalum'.
L. Hanger Rods: (NOTE: All hanger rods shall be trimmed neatly so that no more than 1 inch of excess hanger rod protrudes beyond the hanger nut. In the event a rod is intentionally but temporarily left excessively long (for sloped or insulated lines for example), the contractor shall take appropriate measures to protect the pipe or other materials from damage.)

3.04 FLASHING

M. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked one inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter flash, and seal.

N. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.

O. Seal floor, shower, mop sink, and floor drains watertight to adjacent materials.

P. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.

Q. Provide curbs for mechanical roof installations 12 inches minimum high above roofing surface to allow future roof maintenance. Flash and counterflash with sheet metal; seal watertight. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.

R. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.05 SLEEVES

A. Set sleeves in position in formwork. Provide reinforcing around sleeves.

B. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

C. Extend sleeves through floors (except in stairwells) two inches above finished floor level. Sleeves through floors shall have welded waterstop rings. Sleeves shall be sealed watertight to floors and pipe.

D. Where piping, ductwork or conduit penetrates floor, ceiling, or wall, close space between pipe or duct and adjacent work with fire stopping insulation and caulk air tight. Provide close fitting metal collar or escutcheon covers, as appropriate, at both sides of penetration.

E. Install chrome plated steel or stainless steel escutcheons at finished surfaces.
3.06 PIPE SUPPORT SCHEDULES

<table>
<thead>
<tr>
<th>STEEL PIPE SIZE</th>
<th>MAX. HANGER SPACING</th>
<th>HANGER ROD DIA.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inches</td>
<td>Feet</td>
</tr>
<tr>
<td>1/2 to 1-1/4</td>
<td>6.5</td>
<td>3/8</td>
</tr>
<tr>
<td>1-1/2 to 2</td>
<td>10</td>
<td>3/8</td>
</tr>
<tr>
<td>2-1/2 to 3</td>
<td>10</td>
<td>1/2</td>
</tr>
<tr>
<td>4 to 6</td>
<td>10</td>
<td>5/8</td>
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<tr>
<td>8 to 12</td>
<td>14</td>
<td>7/8</td>
</tr>
<tr>
<td>14 and Over</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>PP, PVDF, PVC, CPVC</td>
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<td></td>
</tr>
<tr>
<td>(All Sizes)</td>
<td>4</td>
<td>3/8</td>
</tr>
<tr>
<td>C.I. Bell and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spigot (or No-Hub),</td>
<td>5</td>
<td>5/8</td>
</tr>
<tr>
<td>and at all Joints</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass,</td>
<td>4</td>
<td>1/2</td>
</tr>
<tr>
<td>and at all Joints</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

END OF SECTION 230529
PART 1 - GENERAL

1.1 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, Supplementary General Conditions, all applicable requirements of Division 1, "General Requirements", and Section 230000, "Basic Mechanical Requirements", govern this Section.

1.2 DESCRIPTION OF WORK:
A. Work Included: Provide vibration isolation supports for all equipment, piping and ductwork as may be required to prevent transmission of vibration and noise to the building structure. Expected noise levels in various parts of the building shall conform to noise criteria recommendations as set forth in the ASHRAE 1987 HVAC Systems and Applications, Chapter 52, Page 52.4. The lowest of the range of NC criteria curves shall apply. It shall be the Contractor's responsibility to select and install vibration isolators which will enable the noise criteria standards to be met to the extent that the noise can be controlled by vibration isolators.

1.3 QUALITY ASSURANCE:
A. General: Except as otherwise indicated, obtain all vibration isolation materials from a single manufacturer.
B. Supervision: Manufacturer shall provide technical supervision of the installation of support isolation units produced by him and of associated inertia bases.
C. Acceptable Manufacturers: Provide products complying with these specifications and produced by one of the following:
   1. Amber/Booth Company, Inc.
   2. Korfund Dynamics Corporation.
   3. Mason Industries.
   4. Metraflex, Inc.
D. Manufacturer Certification: Where vibration isolation support units are indicated for a minimum static deflection, provide manufacturer's certification that units have been tested and comply with the indicated requirements.

1.4 SUBMITTALS:
A. Shop Drawing submittals shall include, but not be limited to, the following:
   1. A complete listing of proposed types of isolators for each specified application, including size and deflection information.
   2. Selection calculations for all isolators with size, type and deflection noted.
   3. Vertical isolation riser diagrams with expansion/contraction calculations.
   4. Cut sheets for each isolator type to be utilized on the project.
5. A clearly outlined procedure for installing and adjusting all isolators.

6. Cut sheets on all furnished bases and frames.

7. Cut sheets on all flexible connectors and application data as required.

8. Additional information as specified in Section 23 01 00.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver vibration isolation materials in factory-fabricated water-resistant wrapping.

B. Handle vibration isolation materials carefully to avoid damage to material component, enclosure and finish.

C. Store vibration isolation materials in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 TECHNICAL REQUIREMENTS:

A. Deflections indicated are minimums and it shall be the responsibility of the isolation manufacturer to determine the amount of spring deflection required for each isolator to achieve optimum performance, prevent the transmission of objectionable vibration and meet the noise criteria referenced herein.

B. Spring type vibration isolators shall be used for all equipment driven by motors of 3 hp and larger, unless otherwise noted. Equipment driven by motors 2 hp and smaller shall be isolated by means of elastomeric mounts or hangers properly sized for 1/2" deflection, unless noted otherwise.

C. All spring isolators shall be completely stable in operation and shall be designed for not less than 30% reserve deflection beyond actual operating conditions. Spring isolators shall be horizontally stable and designed for a minimum kx/ky ratio (horizontal to vertical spring rate) of 1.2 times the static deflection (in inches) divided by the working height (in inches).

D. All elastomeric isolators and isolator components shall be of neoprene or high quality synthetic rubber with antioxidant additives and shall be sized for a maximum load of 60 psi and a rating of 40 durometers.

E. All vibration isolators and bases furnished by the Contractor shall be designed for and treated for resistance to corrosion. Steel components shall be cleaned and painted with industrial grade enamel. All nuts, bolts, and washers shall be zinc-electroplated. Structural steel bases shall be thoroughly cleaned of welding slag and primed with zinc-chromate or metal etching primer. A finish coat of industrial grade enamel shall be applied over the primer.

F. All isolators exposed to the weather shall have steel parts PVC coated, hot dipped galvanized or be of stainless steel. Aluminum components shall be etched and painted with industrial grade enamel.

G. Isolators for equipment installed outdoors shall be designed to provide adequate restraint due to normal wind conditions and to withstand wind loads of 50 pounds/square foot applied to any exposed surface of the isolated equipment. Where isolators do not meet this requirement, stainless steel tie down cables shall be provided.

H. Equipment subjected to excessive horizontal air thrust shall be furnished with isolated thrust resistors to limit displacement to 1/4".

I. Where height-saving brackets for side mounting of isolators are required, the height-saving brackets shall be designed to provide for an operating clearance of 2" under the isolated structure, and
designated so that the isolators can be installed and removed when the operating clearance is 2” or less. When used with spring isolators having a deflection of 2-1/2” or more, the height-saving brackets shall be of the pre-compression type to limit exposed bolt length between the top of the isolator and the underneath side of the bracket.

J. Required spring deflections for isolators supporting various items of equipment are shown on the Drawings or tabulated elsewhere in these specifications, but in no case shall be less than one inch. The springs shall be capable of 30% over-travel before becoming solid.

K. All isolators supporting a given piece of equipment shall limit the length of the exposed adjustment bolt between the top and base to a maximum range of 1” to 2”.

L. All isolators supporting a given piece of equipment shall be selected for approximately equal spring deflection.

2.2 ISOLATOR TYPES:

A. General: Isolator types shall be one or more of the following as listed under Paragraph 2.04, "Equipment Isolation". Model numbers of Amber/Booth products are included for identification. Products of other specified manufacturers are acceptable provided they comply with all of the requirements of the specification.

B. Floor Mounts:

   1. **Type SW**: An adjustable, free-standing, open-spring mounting with combination leveling and equipment fastening bolt. The spring shall be welded to the spring mounting base plate and compression plate for stability. The isolator shall be designed for a minimum kx/ky (horizontal-to-vertical spring rate) of 1.2 times the static deflection (in inches) divided by the working height (in inches). An elastomeric pad having a minimum thickness of 1/4” and sized for a maximum load of 60 psi with a rating of 40 durometers shall be bonded to the base plate. Nuts, adjusting bolts and washers shall be zinc-electroplated to prevent corrosion.

   2. **Type RSW**: An adjustable, free-standing, enclosed spring mounting for integral mounting in a Type CPF base. The isolator shall be designed for a minimum kx/ky (horizontal-to-vertical spring rate) of 1.2 times the static deflection (in inches) divided by the working height (in inches). An elastomeric pad having a minimum thickness of 1/4” and sized for a maximum load of 60 psi with a rating of 40 durometers shall be bonded to the spring base plate. Nuts, bolts and washers shall be zinc electroplated to prevent corrosion. Isolators shall have a steel semihousing with built-in height saving bracket for recessing into a concrete pouring form (CPF) concrete inertia block for side access. Brackets for use with isolators having 2.5 deflection or greater shall be of the precompression type to limit exposed bolt length.

   3. **Type XL**: An aluminum-housed, adjustable spring mounting having telescoping top and bottom sections separated by resilient elastomeric inserts to limit horizontal motion. Steel or cast iron housings may be used if they are hot-dip galvanized after fabrication. The isolator shall be designed for a minimum kx/ky (horizontal-to-vertical spring rate) of 1.2 times the static deflection (in inches) divided by the working height (in inches). An elastomeric pad having a minimum thickness of 1/4” and sized for a maximum load of 60 psi with a rating of 40 durometers shall be bonded to the base plate. Nuts, adjusting bolts, and washers shall be zinc-electroplated to prevent corrosion.

   4. **Type RVD**: An elastomeric mounting having a steel base plate with mounting holes and a threaded insert at top of the mounting for attaching equipment. All metal parts shall be completely embedded in the elastomeric material. Mountings shall be designed for approximately 1/2” deflection.
5. **Type SP-NRE**: A pad type mounting consisting of two layers of 3/8" thick ribbed or waffled elastomeric pads bonded to a 16 gauge galvanized steel separator plate. Pads shall be sized for approximately 20 to 40 psi load and a deflection of 0.12” to 0.16”.

6. **Type CT**: An adjustable, open-spring isolator having one or more coil springs attached to the top compression plate and a base plate. The isolator shall be designed for a minimum kx/ky (horizontal-to-vertical spring rate) of 1.2 times the static deflection (in inches) divided by the working height (in inches). An elastomeric pad having a minimum thickness of 1/4” and sized for a maximum load of 60 psi with a rating of 40 durometers shall be bonded to the base plate. Nuts, adjusting bolts and washers shall be zinc-electroplated to prevent corrosion. The spring assembly shall be removable and shall fit within a welded steel enclosure consisting of a top plate and rigid lower housing, which serves as a blocking device during installation. Isolated restraining bolts which shall not be engaged during normal operation shall connect the top plate and lower housing to prevent the isolated equipment from rising when drained of water.

7. **Type TRK**: A set (two or more) of spring thrust resisting assemblies each consisting of a coil spring, spring retainer, isolation washer, steel washer, angle mounting brackets, and neoprene tubing for isolating thrust resister rod at fan discharge or suction.

C. **Hangers**:

1. **Type BS**: A spring hanger consisting of a rectangular steel box capable of 200% minimum overload without visible deformation, coil spring, spring retainers, neoprene impregnated fabric washer and steel washer.

2. **Type BSR**: A combination spring and elastomeric hanger consisting of a rectangular steel box capable of 200% minimum overload without visible deformation, one inch (1”) deflection coil spring, spring retainers and elastomeric mounting designed for approximately 1/2” deflection, 1-1/2” total deflection.

3. **Type PBS**: A spring hanger consisting of a rectangular steel box capable of 200% minimum overload without visible deformation with the addition of a load transfer plate to hold the equipment or piping at a fixed elevation during installation and to permit transferring the load to the spring after installation, a coil spring, spring retainers, neoprene impregnated fabric washer and steel washer.

4. **Type PBSR**: A combination spring and elastomeric hanger consisting of a rectangular steel box capable of 200% minimum overload without visible deformation, with the addition of a load transfer plate to hold the equipment or piping at a fixed elevation during installation and to permit transferring the load to the spring after installation, a 2” deflection coil spring, spring retainers and elastomeric mounting designed for approximately 1/2” deflection, 2-1/2” total deflection.

5. **Type BRD**: An elastomeric hanger consisting of a rectangular steel box capable of 200% minimum overload without visible deformation and an elastomeric isolation element. The elements shall be designed for approximately 1/2” deflection.

D. **Base Types**:

1. **Type HKP**: A concrete equipment housekeeping pad as specified in Section 23 03 00, "Basic Materials and Methods".

2. **Type CPF**: A concrete inertia base, consisting of perimeter steel concrete pouring form (CPF), with reinforcing bars and isolators welded in place. The perimeter steel members shall have a minimum depth of 1/12 of the longest span, but not less than 6” deep. The base shall be sized with a minimum overlap of 4” around the base of the equipment and, in the case of belt-driven equipment, 4” beyond the end of the drive shaft. Fan bases are to be supplied with NEMA
standard motor slide rails. The bases for pumps shall be sized to support the suction elbow of end suction pumps and both the suction and discharge elbows of horizontal split-case pumps. The bases shall be T-shaped where necessary to conserve space. The CPF base shall be installed over a concrete equipment (housekeeping) pad as specified in Section 23 03 00.

3. **Type RTIR:** An extended aluminum rail base for rooftop air conditioning units consisting of a pair of weatherproofed aluminum rails for fastening to equipment and to the roof curb incorporating wind restraints and a continuous air and water seal which is protected from accidental puncture and direct sunlight by an aluminum weather shield. Rails shall incorporate nonadjustable Type SW spring isolators properly spaced around perimeter and sized for one inch (1") deflection. To prevent leaks, rails shall be factory-assembled (to the limits of freight carriers) and shipped as a one-piece unit.

4. **Type SR:** A set (two or more) of structural steel channel or angle rails to which isolators are rigidly attached. Bolt holes shall be provided for bolting equipment to the rails. Isolators shall be spaced along the rails on sufficiently close centers to limit deflection of the rail to 1/360 of the unsupported span. Isolators shall be Type SW with vertical limit stops or Type RVD as specified.

5. **Type CURB** - An equipment roof curb as specified in Section 23 03 00.

### 2.4 EQUIPMENT ISOLATION:

<table>
<thead>
<tr>
<th>ISOLATOR EQUIPMENT</th>
<th>MINIMUM BASE DEFLECTION</th>
<th>BASE TYPE</th>
<th>TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air Handling Units [*]</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Roof Mounted:</td>
<td>SW</td>
<td>1.0</td>
<td>RTIR</td>
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<tr>
<td>Fan Coil Units [and fan-powered HVAC Terminal units] (Suspended)</td>
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<tr>
<td>Ceiling Mounted A/C Units</td>
<td>BRD</td>
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</tr>
<tr>
<td>Electronic Air Cleaners</td>
<td>BRD</td>
<td>0.5</td>
<td>----</td>
</tr>
</tbody>
</table>

**Fans**

- **Centrifugal - Floor Mounted**
  - Up to 15 hp: [RSW] [SW] [2.5] [1.5] HKP CPF/HKP
  - 20 hp & Over: [RSW] [SW] [2.5] [1.5] HKP CPF/HKP

- **Centrifugal - Suspended**
  - Up to 15 hp: [PBSR] [BSR] [2.0] [1.5] ----
  - 20 hp & Over: PBSR [2.5] [2.0] ----
2.5 PIPING ISOLATION:

A. **Riser Diagrams:** The vibration isolation manufacturer shall prepare and submit riser diagrams for approval. These diagrams shall show anticipated vertical expansion and contraction of various segments of the piping and spring deflection changes. Wall sleeves for take-offs from risers shall be sized for insulation O.D. plus two times these anticipated movements to prevent binding. If flexible connectors or expansion loops to relieve stress are required in the riser system, they shall be furnished whether shown or not at no expense to the Owner or Engineer. Type and design shall be submitted to the Engineer for approval. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the design proposed when installed in accordance with submittals and these specifications.

B. **All horizontal runs of refrigerant piping 1-1/4” and smaller within the building shall be suspended using Amber/Booth Type HRD-1-A or approved equal rubber-in-shear isolators to prevent compressor noise from being transmitted to the building construction.**

C. Domestic water and fire protection systems shall be rigidly supported with flexible connections as shown or specified.

D. Expansion loops and flexible connectors shown on the plans may be omitted provided analysis shows that the piping and equipment connections are not overstressed by their removal. Calculations showing the resultant stress shall be submitted to the Engineer for approval prior to omission of loops and connectors.

E. **Isolator Types:** Piping system vibration isolators shall be as follows:

### Axial Flow - Floor Mounted

<table>
<thead>
<tr>
<th>HP Range</th>
<th>Manufacturer</th>
<th>Spring Rate</th>
<th>Curvature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 15 hp</td>
<td>[SW] [XL]</td>
<td>[1.5] [1.0]</td>
<td>HKP</td>
</tr>
<tr>
<td>20 hp &amp; Over</td>
<td>[RSW] [SW]</td>
<td>[3.5] [2.0]</td>
<td>HKP</td>
</tr>
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### Axial Flow - Suspended

<table>
<thead>
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<th>HP Range</th>
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<th>Spring Rate</th>
<th>Curvature</th>
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</thead>
<tbody>
<tr>
<td>Up to 15 hp</td>
<td>[PBSR] [BSR]</td>
<td>[1.5] [1.0]</td>
<td>----</td>
</tr>
<tr>
<td>20 hp &amp; Over</td>
<td>PBSR</td>
<td>[2.5] [2.0]</td>
<td>----</td>
</tr>
</tbody>
</table>

**Roof Mounted Fans**

- Isolators furnished with equipment

**In-line Pumps**

- None

**Air Cooled Condensing Units**

- Roof Mounted
  - Up to 5 Tons: SP-NRE 0.15 CURB
  - 7-1/2 Tons to 20 Tons: CT 1.0 CURB

**Computer Room A/C Units**

- Direct mount with neoprene gasket

**Water Heaters**

- HKP

* SP-NRE with 0.15" deflection for internally isolated air handling units in the mechanical rooms.
** For pumps installed in the Central Plant.
*** For pumps installed in the Mechanical Penthouse.
**** SP-NRE with 0.15" deflection for air compressors installed in the Central Plant.
1. Type PBS for first two hangers in horizontal piping adjacent to isolated equipment and for all hangers on 8" and larger pipe, except the first two hanger points adjacent to riser shall be Type BS.

2. Type BS for remaining hangers in horizontal piping.

3. Type SW for pipe risers. Isolator base plates shall be provided with holes for bolting and isolation grommets.

4. Type SW for floor supports except Type CT for first floor support adjacent to equipment isolated on CT isolators.

2.6 DUCTWORK ISOLATION:

A. General: Rigidly support all ductwork with flexible duct connections at equipment.

PART 3 - EXECUTION

3.1 PERFORMANCE OF ISOLATORS:

A. General: Comply with the minimum static deflections recommended by the American Society of Heating, Refrigerating and Air Conditioning Engineers including the definitions of critical and noncritical locations, for the selection and application of vibration isolation materials and units as indicated.

B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's instructions for selection and application of vibration isolation materials and units.

3.2 INSTALLATION:

A. General: Except as otherwise indicated, comply with manufacturer's instructions for the installation and load application of vibration isolation materials and units. Adjust to ensure that units do not exceed rated operating deflections, do not bottom out under loading, and are not short circuited by other contacts or bearing points. Remove space blocks and similar devices (if any) intended for temporary protection against overloading during installation.

B. Secure Attachment: Anchor and attach units to substrate and equipment for secure operation, to prevent displacement by normal forces.

C. Adjustment: Adjust leveling devices to distribute loading uniformly onto isolators. Shim units where leveling devices cannot be used to distribute loading properly.

D. Base Frames: Install inertia base frames on isolator units so a 2" (minimum) clearance below base will result when frame is filled with concrete and supported equipment has been installed and loaded for operation.

E. Isolation Hangers: Locate isolation hangers as near the overhead support structure as possible.

F. Welding: Weld riser isolator units in place to prevent displacement from loading and operations.

G. Airtight Connections: Bond flanges of flexible duct connectors to ducts and housings to provide airtight connections. Seal seams and penetrations to prevent air leakage.

3.3 EXAMINATION OF RELATED WORK:

A. Examination and Reporting: Installer of vibration isolation work shall observe the installation of other work related to and connected to vibration isolation work. After completion of other related work (but before equipment start up), he shall furnish a written report to the Contractor, with copy to the
Engineer, listing observed inadequacies for proper operation and performance of vibration isolation work. Report shall cover, but not necessarily be limited to, the following:

1. Equipment installation (performed as work of other Sections) on vibration isolators.
2. Piping connections including flexible connections.
3. Ductwork connections including provisions for flexible connections.
4. Passage of piping which is to be isolated through walls and floors.

B. Correction and Start-up: Do not start up equipment until inadequacies have been corrected in a manner acceptable to the vibration isolation installer.

3.4 DEFLECTION MEASUREMENTS:
   A. Report: Upon completion of vibration isolation work, prepare report showing measured equipment deflections for each major item of equipment as indicated. Submit all reports to the Engineer for final review.

3.5 FIELD SERVICES:
   A. Representative: The isolation materials manufacturer shall provide the services of an authorized representative to supervise and ensure correct installation of isolators and sound attenuation materials and proper adjustment of the isolators after installation. Upon completion of the installation and after the system is put into operation and before acceptance by the Owner, the authorized manufacturers representative shall make a final inspection and submit his report to the Architects and Engineers, in writing, certifying the correctness of the vibration isolation installation and compliance with approved submittal data. Any discrepancies or maladjustments found shall be so noted in the report and shall be corrected by the Contractor and accepted in writing by the authorized manufacturers representative. Should any noise or vibration be objectionable to the Owner, Architect or Engineer, the Contractor shall provide the services of a qualified Vibration/Noise Consultant shall provide a field instrumentation test and at no cost to the Owner or Architect/Engineer. Any variation or noncompliance with these specification requirements is to be corrected by the installing contractor in an approved manner.

3.6 EQUAL LOADING:
   A. General: All equipment installed on vibration isolation mountings shall be level after load is applied. Further, vibration isolation mountings shall be selected and installed to compensate for unequal loading. Spring isolators with coils touching during equipment start up or operation will not be acceptable.

END OF SECTION 23 05 48
SECTION 230553

MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:
   A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, Supplementary General Conditions, all applicable requirements of Division 1, “General Requirements”, and Section 230000, “Basic Mechanical Requirements”, govern this Section.
   B. Section 230000 – Basic Mechanical Requirements
   C. Section 230529 – Sleeves, Flashings, Supports and Anchors

1.2 SECTION INCLUDES
   A. Nameplates
   B. Tags
   C. Stencils
   D. Pipe Markers

1.3 REFERENCES
   A. ASME A13.1 - Scheme for the Identification of Piping Systems

1.4 SUBMITTALS
   A. Submit under provisions of Section 230000.
   B. Submit list of wording, symbols, letter size, and color coding for mechanical identification.
   C. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer’s name and model number.
   D. Product Data: Provide manufacturers catalog literature for each product required.
   E. Samples: Submit two of each type of label, tag, etc., of the approximate size specified or implied in the specification.
   F. Manufacturer’s Installation Instructions: Indicate special procedures, and installation.

1.5 PROJECT RECORD DOCUMENTS
   A. Submit under provisions of Section 230000.
   B. Record actual locations of tagged valves.

PART 2 - PRODUCTS

2.1 NAMEPLATES
   A. Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.
2.2 TAGS
   A. Manufacturers:
   B. Metal Tags: Stainless Steel with stamped letters; tag size minimum 1-1/2 inch (40 mm) diameter with smooth edges.
   C. Chart: Typewritten letter size list in anodized aluminum frame.

2.3 PIPE MARKERS
   B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
   C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
   D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches (150 mm) wide by 4 mil (0.10 mm) thick, manufactured for direct burial service.

2.4 PIPING
   A. Pipe markers and arrow markers also shall be provided on but not limited to the piping of the following systems:
      1. Domestic Cold Water Supply
      2. Domestic Hot Water Supply
      3. Domestic Hot Water Return
      4. Rainwater Supply
      5. Sanitary Sewer
      6. Sanitary Vent
      7. Storm Drain

2.5 ELECTRICAL:
   A. Nameplates shall be 2 or 3 ply laminated plastic, a minimum of 3/32" thick, such that letters will be white on black background. Letters shall be similar to Roman Gothic of a size that is legible and appropriate to the application. Attachment of nameplates shall be by screws. Rivets or adhesives are not acceptable.
   B. Electrical equipment to be identified includes: All switchgear, distribution panels, transformers, motor control centers, panel boards, disconnect switches, starters, contactors and time switches.
   C. Nameplates on distribution panels, motor control centers and panel boards shall give voltage characteristics.
      Example:
      PANEL LA
      120/208V, 3 PH, 4 W served from .
   D. Individual circuit breakers in distribution panels, individual units in motor control centers, disconnecting means, and motor starters, shall have nameplates showing the load served.
E. Branch circuit panel boards shall have neatly typed circuit directories behind clean plastic. Identify circuits by room numbers. Room numbers shall be those finally selected by the Owner, not necessarily those given on contract Drawings. If a circuit serves more than one room, list each room. Spares and spaces shall be indicated with erasable pencil, not typed.

2.6 VALVE CHART:

A. The Contractor shall prepare and install, in a suitable glazed frame, typewritten valve charts giving the number, location and function of each line valve installed under this Contract. Each valve shall be numbered on these charts in accordance with the system of which it is a part of its location. For example, valves in different systems would be designated as follows:

| DCW-1 Cold Water Supply | Valve No. 1 |

2.7 VALVE TAGS:

A. The Contractor shall provide and install identification tags lettered and numbered to correspond to the information shown on the charts described above. These tags are to be affixed to all valves except simple service and drain valves located within 10’ and within sight of the device or equipment served. For example, it would not be expected that valves at a pressure reducing station in a machine room would be tagged. These tags shall be 1/8” thick brass discs, 1 1/2” in diameter. Each tag shall be attached to its valve with copper clad annealed iron wire or other approved material.

B. Valves at water headers and other valves as specified shall also be tagged with standardized color coded plastic tags. These tags shall be 2 1/2” wide by 1 1/2” high with these color codings: Red = normally closed; Green = normally open; Blue = open in winter, closed in summer; and Yellow = closed in winter, open in summer. Tags should be engraved on both sides.

2.8 SPECIALS: REFER TO SPECIAL REQUIREMENTS NOTED IN THE VARIOUS SECTIONS HEREINAFTER BOUND.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces for stencil painting where applicable.

3.2 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Apply stencil painting in accordance with owner’s requirements.

D. Install plastic pipe markers in accordance with manufacturer's instructions.

E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
F. Install underground plastic pipe markers 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.

G. Identify valves in main and branch piping with tags.

END OF SECTION 230553
SECTION 23 07 00
SYSTEM INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, Supplementary General Conditions, all applicable requirements of Division 1, "General Requirements", and Section 230000, "Basic Mechanical Requirements", govern this Section.
B. Refer to Section 23 31 13, "Ductwork", for duct lining requirements and Section 23 37 13, "Air Distribution Devices", for additional insulation requirements.

1.2 DESCRIPTION OF WORK:
A. Work Included: Provide piping, ductwork, and equipment system insulation as specified.

1.3 QUALITY ASSURANCE:
A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
   1. Armstrong World Industries.
   2. Certain-teed Corporation.
   3. Rubatex LLC
   4. Resolco Insul-phen
   5. Schuller.
   6. Owens/Corning Fiberglass.
   7. Pittsburgh Corning.

1.4 SUBMITTALS:
A. Shop Drawings submittals shall include, but not be limited to, the following:
   1. Cut sheets on all insulation products to be used.
   2. Cut sheets on all mastics and other products to be used with insulation products.
   3. Cut sheets on PVC and aluminum jacketing materials.
   4. Manufacturer's printed installation instructions for all of the above products.
   5. Additional information as required in Section 23 01 00.

1.5 DELIVERY, STORAGE AND HANDLING:
A. Store insulation products in their factory-furnished coverings, and in a clean, dry indoor space which provides protection against the weather.
PART 2 - PRODUCTS

2.1 MATERIALS:

A. **Quality**: The type of insulation and its installation in accordance with this Section of the Specifications for each service and the application technique shall be as recommended by the manufacturer.

B. **Fire Rating**: All insulation shall have a composite (insulation, jacket or facing and adhesive used to adhere facing or jacket to insulation) fire and smoke hazard, as tested by ASTM E84, NFPA 255, and UL 723, not to exceed:

1. Flame Spread 25.
2. Smoke Developed 50.

C. **Accessories**: Accessories such as adhesives, mastics, tapes, and cements shall have the same component ratings as listed.

D. **Labels**: Label products and their shipping cartons indicating that flame spread and smoke developed ratings do not exceed the above requirements.

2.2 INSULATION THICKNESS:

A. **Minimum**: Insulation thickness shall not be less than the following:

<table>
<thead>
<tr>
<th>Equipment Surface</th>
<th>Insulation Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilled water pumps</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Chillers</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Water-to-water heat exchangers</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>Steam-to-water heat exchangers</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>Cooling tower basins &amp; sumps</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Steam and steam condensate vessels</td>
<td>2&quot;</td>
</tr>
<tr>
<td>Diesel engine silencers and exhaust piping</td>
<td>3&quot;</td>
</tr>
<tr>
<td>Heating water [and auxiliary condenser water] pumps</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>Coils</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>Compression/expansion tanks</td>
<td>1&quot;</td>
</tr>
</tbody>
</table>
| [House, surge and water storage tanks | 1"
| Boiler stack and breeching | 2" |
| Outside air fans  | 1"                  |
| Condensate drain pans | 1" |

**Piping Surface**
SYSTEM INSULATION

Chilled water 1" and smaller, domestic refrigerated water

Refrigerant piping

Condensate drain piping (except above drain pans and less than one foot (1') at floor drains)

Roof and overflows drains (underside), horizontal downspouts, underside of drains (including traps) and horizontal drain lines from chilled water drinking fountains and drains receiving cooling coil condensate.

Plastic acid waste and vent lines

Domestic hot water lines 2" and smaller

Domestic hot water lines 2-1/2" and larger

Domestic cold water mains, risers and horizontal runouts

Handicapped All exposed] lavatory traps, tailpieces hot and cold water supplies

Deionized (treated) water lines

Cooling tower make-up water lines

Garage fire and domestic water lines exposed to outdoor temperatures 2-1/2" and smaller

All otherwise uninsulated pipe exposed to outdoor temperatures

Ductwork Surface

Conditioned air and return air, ductwork, external wrap (where not lined)

Air devices***

Kitchen exhaust ductwork

Wet exhaust ductwork

Ductwork, acoustical lining (see Section 23 31 13).

Return air ductwork, exterior wrap ***

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* Where exposed to outdoor ambient temperature, increase insulation thickness by 1/2"

** Unless noted otherwise.

*** Where located in non-return air plenums (e.g. ducted return areas).

2.3 EQUIPMENT:

A. **Hot (110° F to 200° F) and Cold (Below 60° F) Surfaces**: Provide Armstrong Type II "Armaflex", "Robatex", or an approved equal flexible closed cell elastomeric sheet insulation. Insulation shall have a K factor of not more than 0.28 Btu/inch-per degree F-per hour at 75° F mean temperature and a water vapor permeability of 0.15 perm-inch or less. Insulation shall have a flame spread rating of 25 and a smoke-developed rating of 50 for thicknesses up to 3/4" and 200 for one inch (1") thickness. Provide manufacturers recommended adhesive (Armstrong 520 or an approved equal.)
B. High Temperature (200°F and Above) Surfaces: Provide Schuller "Thermo-12" or an approved equal hydrous calcium silicate in scored block or beveled block form, as best suited for the intended use. Where exposed to weather, provide Schuller "Metal-On" or approved equal metal weatherproof jacket.

2.4 PIPING:

A. Chilled and Hot Water Pipe Insulation: Provide Resolco International by (Insul-Phen) or an approved equal pre-formed Phenolic closed cell insulation; ASTM E96, maximum water vapor transmission rating of 0.02 Perm-In; ASTM C1126 rigid foam, 3.75 lbs. nominal density, CFC free; ASTM C518, 'k' value of 0.16 at 75 degrees F., and 5.0 lbs. nominal density, CFC free; ASTM C518, 'k' value of 0.21 at 75 degrees F. (Note material thickness limit is 3 inches as tested in accordance with ASTM E84).

B. Calcium Silicate Pipe Insulation (Steam Supply Piping): Provide Schuller Thermo-12, Owens/Corning Kaylo AF or an approved equal pre-formed calcium silicate insulation. Calcium silicate pipe insulation sections shall be pre-formed specifically for the pipe sizes on which it is used. Calcium silicate insulation shall be held in place with 20 gauge galvanized wire on 9" centers. Sections shall be formed to proved tightly butted joints. Material shall have a K factor of 0.55 at 500° F mean.

C. Fitting Insulation: Provide pre-molded rigid insulation for valves, fittings, flanges, strainers, and unions. Insulation shall be as specified for pipe insulation, except without the all-service jacket, where applicable.


E. Existing and/or repaired Phenolic Insulation: Provide Venture 1577 W/U, 0 perm and mold resistant jacket material, 5 ply laminate with 6 mil film on with adhesive on one side.

F. Fiberglass Cloth Reinforced Mesh: Provide # 10 glass cloth with minimum weight of 3.9 ounces per square yard. Color shall be white unless noted otherwise.

G. PVC Jacketing: Provide pre-rolled protective jacketing where required or specified for protection of the insulation all service jacket. PVC jacketing shall be 30 mil thickness. All joints shall be made by lapping the jacket and sealing with an approved PVC welding adhesive.

H. Metal Jacketing: Provide 0.016" thick aluminum jacketing where required or specified. 3/4" x 0.015" stainless steel bands and straps shall be provided for banding insulation jacketing.

I. Elastomeric Insulation: Provide Armstrong Type II "Armaflex" or approved equal closed cell elastomeric insulation. Insulation shall have a K factor of not more than 0.28 Btu/inch per degree F-per hour at 75° F mean temperature and a water vapor permeability of 0.15 perm-inch or less. Insulation shall have a flame spread rating of 25 and a smoke developed rating of 50. Provide manufacturers recommended adhesive (Armstrong 520 or Manville No. 57).

J. Lavatory Piping: Provide Truebro Model #102 or Plumberex PR0-2000 series or equal fully molded, flexible vinyl insulation system for insulating lavatory traps and hot and cold water supplies.

K. Miscellaneous: Provide all miscellaneous accessories, components and materials required for installation of a complete insulation system.

2.5 DUCTWORK:

A. External Ductwork Insulation: Provide Schuller "Microlite" R-Series or an approved equal [1-1/2"] [2"] [2-1/2"] [3"] thick flexible fiberglass duct wrap with fiberglass reinforced kraft-scrim-foil vapor barrier
jacket. Ductwrap shall have a density of 0.75 pounds per cubic foot, K factor of 0.31 at 75° F and a permeability of 0.04 perm. Insulation shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less.

B. **Acoustical Duct Lining:** Lining provided with ductwork, refer to Section 23 31 13.

C. **Kitchen Exhaust Ductwork:** Provide [calcium silicate insulation as specified hereinabove for "High Temperature (200° F and Above) Surfaces"][High temperature fiberglass blanket (1000° F) insulation, 2# density with a K-factor of 0.23 at 75° F. Insulation shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less.]

### PART 3 - EXECUTION

#### 3.1 INSTALLATION:

A. **General:** Install insulation products in accordance with the manufacturer's written instructions, the Midwest Insulation Contractors Association (MICA) Commercial and Industrial Insulation Standards, and recognized industry practices to ensure that the insulation serves the intended purpose. Surfaces to be insulated shall be thoroughly cleaned with all testing successfully completed prior to insulation.

#### 3.2 EQUIPMENT APPLICATION:

A. **Chilled [and Heating Hot] Water Pumps:** Apply sheet insulation to the surface to be insulated with adhesive over the entire surface. The entire insulation installation shall be in accordance with application recommendations described in the latest published manufacturers pamphlets. All lap and butt joints shall be sealed vapor tight. The insulation shall be finished with two coats of manufacturer's finish coating, vinyl-lacquer coating, or approved equal, color to be [manufacturer's standard][as selected by the Owner]. Application shall be such that removal of the pump casing or a pump casing section will not destroy the installation, and as detailed on the Drawings.

B. **Water Chillers and Heat Exchangers:** Apply sheet insulation to hot heat exchangers and non-factory insulated cold surfaces on water chillers with adhesive over the entire surface being insulated. The entire insulation installation shall be in accordance with application recommendations described in the latest published manufacturers pamphlets. All lap and butt joints shall be sealed, vaportight on cold surfaces, using the manufacturers recommended adhesive. The insulation shall be finished using two coats of the manufacturer's finish coating, vinyl-lacquer coating, or approved equal, color to be [manufacturer's standard][or selected by the Owner]. Insulation installation shall have removable sections to allow maintenance access.

C. **Compression/Expansion Tanks and Water Storage Tanks:** Apply sheet insulation to the entire surface with recommended adhesive. Apply adhesive over the entire clean dry bare metal surface and all butt and lap joints shall be sealed vaportight. The entire insulation installation shall be in accordance with application recommendations described in the latest manufacturers pamphlets. The insulation shall be finished with two coats of manufacturer's finish coating, vinyl-lacquer coating, or approved equal, color to be [manufacturer's standard][as selected by the Owner].

D. **Diesel Engine Exhaust Pipes and Silencer, Boiler Stack, and Breeching and High Temperature Heat Exchangers and Converters:** After all pressure tests have been completed, apply calcium silicate insulation with joints staggered to clean, dry metal surfaces, which have not been factory-insulated and hold in place with one inch (1") galvanized hexagonal wire mesh with edges laced together. Where necessary to achieve snug fit of insulation on large surfaces, install weld clips 18" on center to surfaces before installation of insulation and tie to wire mesh with 20 gauge galvanized wire. Cover insulation with two 1/4" thick coats of insulating cement troweled to a smooth finish and reinforced with one inch (1") hex wire mesh. When cement has cured, apply a layer of 20 x 20 mesh...
TPWD Cedar Hill State Park Flood Repairs
TPWD No. 128269
HZ No. R302179.02

SYSTEM INSULATION

100% Construction Documents – 03-15-2019 230700 - Page 6
E&C No. 3420.00

E. Exterior Installations: Where systems are exposed to ambient temperatures or wet conditions and elsewhere as specified, provide an aluminum jacketing system specifically designed for exterior installation. All longitudinal seams shall be located at the 3 o’clock and 9 o’clock position with a minimum 3” overlap oriented to shed water from entry. Butt joints shall be overlapped a minimum of 3” in a manner to prevent the entry of water. Seal metal jacketing with straps on maximum 12” centers. Locate strap joints so as to prevent personnel contact. A factory-applied metal jacket on calcium silicate systems meeting all aspects of this specification may be used where exposed to ambient temperatures or wet conditions if installed per the manufacturers recommendations.

F. Cooling Tower Basins and Sumps: Insulate as specified for water chillers. Finish with two coats of exterior grade vinyl coating applied per the manufacturers recommendations.

G. Outside Air Fans: Insulate all outside air fans located in enclosed spaces and not exposed to outside temperatures as specified for water chillers.

H. Condensate Drain Pans: Insulate all non-factory-insulated drain pans as specified for water chillers.

I. Steam and Steam Condensate Vessels: Insulate all non-factory-insulated surfaces as specified for boiler breaching where surface temperatures exceed 200°F. [Atmospheric pressure receiver condensate pump units do not require full insulation.]

J. Heating and Cooling Coils: Insulate all coil perimeter surfaces that are not factory-insulated with fiberglass insulation as specified for external duct insulation.

3.3 PIPING APPLICATION:

A. General: Apply insulation to clean, dry pipes after all pressure tests have been completed. Firmly butt all joints of insulation and seal all joints per manufacturers recommendations. Install insulation in strict accordance with these specifications and the manufacturer’s printed instructions.

B. Flanges, Strainers and Unions: Insulate flanges, strainers, and unions with pre-molded or shop-fabricated rigid insulation of same material and thickness as specified for adjacent piping. Cover fiberglass and polyurethane insulation with pre-molded PVC covers, held in place with Zeston “Z-tape” or an approved equal. Covers and finish for foam glass and calcium silicate insulation shall be as specified for the adjacent pipe insulation. Ensure that insulation and covers for flanges, unions, and access plates shall be removable without damage to insulation or jackets.

C. Valves and Fittings: Insulate and cover valves, tees, elbows, test parts, and other fittings the same as flanges and unions.

D. Lavatories: Where specified, insulate exposed tailpieces, traps, and hot and cold water supplies with fully molded, flexible vinyl insulation installed per the manufacturers recommendations.

E. Chilled Water Piping: Install pre-formed Phenolic insulation to provide a continuous vapor barrier/insulation system. Insulation shall be installed on piping with butt joints staggered and all joints buttered with Pittseal 444 or approved equal sealant and tightly butted together. Secure insulation with stainless steel bands with a minimum of two bands per insulation section. Cracked or damaged insulation shall be replaced. Valves, fittings, and accessories shall be insulated to the same thickness of insulation specified for piping and shall use step-type layering or pre-formed insulation. Butt joints shall be rested to avoid gaps or voids. Fill contour space between insulation and valves and fittings with light density fiberglass. At valves, fittings, and accessories and at intervals not exceeding 50’ on straight runs of pipe, form an isolating seal between the insulation and the bare pipe by liberal application of butt joint sealant. Coat the installed Phenolic with a tack coat of Pittcoat 300 or approved equal vapor barrier mastic per manufacturers recommendations, embed glass fabric adhered with Insul-Coustic IC 102 and then give a flooding brush coating of IC 102.] [Cover insulation with 2” fiberglass pipe insulation as specified for heating hot water piping.]
F.  [Chilled Water,] [Domestic Refrigerated Water, [Pumped AHU Condensate,] Condensate Drains, Drains Receiving Condensate and from Refrigerated Water Drinking Fountains, Roof Drains, Overflow Roof Drains, and Horizontal Roof, Areaway, and Overflow Roof Drain Leader Piping]: Install pre formed fiberglass insulation to provide a continuous external vapor barrier on all pipe insulation. Seal insulation lap joints using [Insul-Coustic No. 215 or equal vapor barrier adhesive on insulation butts and] the manufacturer's standard pressure sensitive self-sealing lap joint system. Seal butt joints using [Insul-Coustic No. 215 or equal vapor barrier adhesive on insulation butts and] the manufacturer's standard pressure-sensitive closure strip system. Butt strips shall be a minimum of 3" wide. Where insulation is interrupted at fittings, unions, flanges, or valves and at intervals not exceeding [24] [50] on straight runs of pipe, form an isolating seal between the insulation vapor barrier and the bare pipe by liberal application of Insul-Coustic No. 215 or equal vapor barrier adhesive.  Extend the adhesive 2" along the insulation jacket, across the face of the insulation and 4" along the pipe.  [At the Contractors option, roof drain bodies and horizontal roof drain piping may be insulated using exterior ductwrap installation with a continuous vapor barrier.]  [Install a protective outer covering using a metal jacket system over [all] [exposed interior and exterior] pipe [and fitting] insulation.  [Metal jacketing is not required over indoor PVC fitting covers.]  Refer to Paragraph 3.03/P for additional requirements.]

G.  Domestic Hot and Cold Water Piping, Heating Hot Water Piping, Kitchen Grease and Kitchen General Waste Lines and other Piping which is Insulated where Exposed to Outdoor Temperatures: Install phenolic insulation to provide a continuous external vapor barrier on all pipe insulation. Seal insulation lap joints using the manufacturer's standard pressure-sensitive self-sealing lap joint system. Seal butt joints using the manufacturer's standard pressure-sensitive closure strip system. Butt strips shall be a minimum of 3" wide. At the Contractor's option, staples (as specified for steam and condensate piping) may be used in lieu of self-sealing closures for hot piping.  [Install a protective outer covering using a metal jacket system over [all] [exposed interior and exterior] pipe [and fitting] insulation.  [Metal jacket is not required over indoor PVC fitting covers.]  Refer to Paragraph 3.03/P for additional requirements.]

H.  Steam and Steam Condensate Piping:  [Install calcium silicate insulation on the entire piping system. Seal insulation lap joints on pre-formed fiberglass using insulation staples on 2" centers. Seal edge of lap joints with Insul-Coustic No. 215 or equal adhesive or a pressure sensitive tape strip to provide a seal to prevent water entry.  Seal butt joints using the manufacturer's standard pressure-sensitive closure strip system.  Butt strips shall be a minimum of 3" wide.]  [Install pre-formed calcium silicate insulation on piping and fittings with butt joints staggered and with insulation firmly wired in place with a minimum of six loops of 16 gauge copper clad iron wire per 3' section.  Loop ends shall be twisted together tightly and bent over and hammered into the insulation so as to leave no projection. All cracks and voids in the insulation shall be filled with Manville 301 or approved equal cement such that the resulting surface is smooth and continuous.  A layer of 40 pound rosin-sizing paper shall be wrapped around the insulation and an 8 ounce canvas jacket shall be pasted in place. The canvas jacket shall be finish-coated and sized for color-coded finish-painting.]  [Install a protective outer covering using a metal jacket system over [all] [exposed interior and exterior] pipe [and fitting] insulation.  [Metal jacket is not required over indoor PVC fitting covers.]  Refer to Paragraph 3.03/P for additional requirements.]

I.  Refrigerant Piping:  Install phenolic insulation (if specs allow) to refrigerant and hot gas lines.  Seal all butt joints using the manufacturers recommended adhesive.
J. **Hangers and Supports**: Blocking (for piping with a vapor barrier) or saddles (for piping without a vapor barrier) shall be provided at all hanger and support locations. Install insulation inside all pipe saddles. Extend vapor barrier across all pipe blocking. Refer to Section 23 03 00, "Basic Materials and Methods", for additional requirements.

K. **Pipe Anchors**: Insulate pipe anchors as specified for piping. Provide an isolating seal at anchors on piping with a vapor barrier as specified under Paragraph 3.03/D.

L. **Pipe Accessories**: Valve operators, pressure/temperatures plugs, meters and gauge fittings and all other items which extend through required insulation shall be suitably insulated with removable caps to allow use without disturbing the insulation.

M. **Heat Tracing**: Where pipe is heat-traced, the insulation size shall be increased accordingly.

N. **Central Plant and Mechanical Room Protective Covering**: Protect the insulation jacket on all fiberglass and polyurethane insulation and accessories in the Central Plant [and] [and tunnels] [and within 6'-0" of finished floor in mechanical and air handling unit rooms] with a field-installed covering using [vapor barrier mastic and reinforcing mesh installed per the manufacturers recommendations] [except where metal jacket is specified]. [The insulation surface, covering or jacket on all piping in the Pump Room, Mechanical Rooms, and tunnels shall be sized, coated and prepared as required for finish color-coded painting.]

O. **Below Grade Protective Jacket**: Protect outer covering of insulation on below grade piping to 2' above grade with a sealed PVC jacket. All joints shall be sealed watertight. The outer jacket shall be protected with a double layer wrap of 30 pound roofing felt prior to backfill. Care shall be taken during backfill to avoid damage to the insulation and jacket.

P. **Metal Protective Jacket**: Protect outer covering of insulation with a metal jacket system over both pipe and fitting insulation where exposed to weather or where exposed indoors. Metal jacket shall extend over PVC jacketing or vapor barrier, down to grade at riser locations or building entrance. Longitudinal seals shall provide a 3" overlap installed at the 9 o'clock or 3 o'clock position to shed water. Butt joints shall be overlapped a minimum of 3" in a manner to prevent the entry of water. Seal metal jacketing with 3/4" stainless steel sealing bands shall be installed on 12" centers along the metal jacket. Locate strap joints so as to prevent personnel contact. Metal jacket on valves and flanges shall be removable without disturbing the adjacent jacket.

Q. **Vapor Barrier**: Maintain integrity of vapor barrier on chilled water and all other cold pipe insulation and protect barrier to prevent puncture and other damage.

R. **Penetrations**: Extend piping insulation without interruption through walls, floors, and similar penetrations, except where otherwise indicated. Where insulation is interrupted on chilled water piping, an isolating seal shall be provided between the insulation vapor barrier and the pipe and penetration seal as specified under Paragraph 3.03/D. Where insulation is interrupted on steam and condensate piping, the penetration seal shall be insulated as specified for the penetrating piping, such that no high temperature surfaces are exposed.

S. **Ventilation**: Provide adequate ventilation during initial start-up of piping systems to remove smoke and odor given off when the organic binders in the insulation are initially heated.

3.4 **DUCTWORK APPLICATION**:

A. **Exterior Ductwrap Insulation On Supply, Return**: After ductwork testing has been completed, insulate Supply and Return ductwork as specified in section 2.5 above. On ducts over 18" wide, apply weld clips to bottom of duct, spaced 18" on center each way, maximum. Seal all longitudinal and transverse seams and all punctures caused by weld clips or stick clips with 2" wide SMACNA-labeled duct tape and mastic.
B. Acoustical Duct Lining For Supply, Return and General Exhaust Ductwork: Refer to Section 22 31 13 for additional information.

C. **Rigid Ductwork Insulation**: Provide rigid external duct insulation where shown on the drawings and for all exposed ductwork in the [ ] Room. Insulation shall be secured to the ductwork with mechanical fasteners, "stick clips", Graham Pins or Speed Clips spaced on maximum 12" centers on the bottom of the duct and maximum 24" centers on the top and side of the duct. Additional fasteners shall be provided as recommended by the insulation manufacturer or required to hold insulation securely against the duct. After the insulation is in place, all joints, seams and protrusions through the duct shall be thoroughly sealed with Foster 30-35 or approved equal white vapor barrier emulsion applied over 3" wide Duramesh Glass Fabric or approved equal glass fabric strips. Where ductwork has standing seams or external angle bracing, insulation shall be built up over protrusions and sealed as described hereinabove.

D. **Ductwork Insulation Accessories**: Provide staples, bands, wires, tape, anchors, corner angles, cements adhesives, coatings, sealers, protective finishes, and similar compounds as recommended by the insulation manufacturer for the applications indicated.

E. **Air Devices**: Insulate all air devices not factory-insulated with fiberglass ductwrap where diffusers are located in ceilings that are not used as return air plenums.

F. **Special Applications**: Roof drains and floor drains may be insulated with duct wrap if the Contractor submits and receives approval on his recommended means of maintaining a vapor seal.

G. **Surfaces**: Install insulation materials with smooth, even surfaces.

H. **Butt Joints**: Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

I. **Vapor Barrier**: Maintain integrity of vapor barrier on ductwrap insulation and protect barrier to prevent puncture and other damage.

J. **Penetrations**: Extend ductwrap insulation without interruption through walls, floors, and similar ductwork penetrations, except where otherwise indicated.

K. **Corner Angles**: Install corner angles on external corners of insulation on ductwrap in exposed finished spaces before covering with jacketing.

3.5 **INSPECTION**:

A. **General**: Visually inspect the completed insulation installation and repair or replace any improperly sealed joints.

B. **Wet Insulation**: Where there is evidence of vapor barrier failure or "wet" insulation after installation, the damaged insulation shall be removed, the pipe or duct surface shall be cleaned and dried and new insulation shall be installed.

3.6 **IDENTIFICATION**:

A. Refer to Section 23 03 00 for applicable painting and labeling requirements.

END OF SECTION 23 07 00
SECTION 230719

PIPING INSULATION

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, Supplementary General Conditions, all applicable requirements of Division 1, "General Requirements", and Section 230000, "Basic Mechanical Requirements", govern this Section.

B. 230000 -- Basic Mechanical Requirements

C. 230529 -- Sleeves, Flashings, Supports and Anchors

D. 230553 -- Mechanical Identification

1.2 SECTION INCLUDES

A. Piping insulation

B. Jackets and accessories

1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 221000 and 221031 - Plumbing Piping: Placement of hangers and hanger inserts.

1.4 REFERENCES

A. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.


E. ASTM C449 - Mineral Fiber Hydraulic-setting Thermal


G. ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.

H. ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

J. ASTM C552 - Cellular Glass Block and Pipe Thermal Insulation.

K. ASTM C578 - Preformed, Block Type Cellular Polystyrene Thermal Insulation.

L. ASTM C585 - Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).

M. ASTM C591 - Rigid Preformed Cellular Urethane Thermal Insulation.

N. ASTM C610 - Expanded Perlite Block and Pipe Thermal Insulation.

O. ASTM C640 - Corkboard and Cork Pipe Thermal Insulation.


Q. ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.


S. ASTM D2842 - Water Absorption of Rigid Cellular Plastics.


W. UL 723 - Surface Burning Characteristics of Building Materials.

1.5 SUBMITTALS

A. Submit under provisions of Section 230000.

B. Product Data: Provide product description, list of materials ‘k’ value, ‘R’ value, mean temperature rating, and thickness for each service, and locations.

C. Samples: When requested, submit two samples of any representative size illustrating each insulation type.

D. Manufacturer’s Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.6 QUALITY ASSURANCE

A. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor’s
submittal data for this section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

B. All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3”). Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight. Piping, flexible connections, flanges, valves, strainers, and unions shall be covered unless specifically noted otherwise. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable. Refer to Section 23 00 00.

C. All piping, equipment, ductwork, all plenums including metal and masonry construction, fans, etc., shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.

D. To be considered, alternate materials shall have equivalent thermal and moisture resistance of the specified materials.

1.7 QUALIFICATIONS

A. All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation.

B. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation. The company performing the work of this section shall have a minimum of three years experience specializing in the trade.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Section 230000.

B. Deliver materials to site in original factory packaging, labeled with manufacturer’s identification, including product thermal ratings and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

C. All insulation materials to be asbestos free.
PART 2 - PRODUCTS

2.1 MATERIALS:

A. Quality: The type of insulation and its installation in accordance with this Section of the Specifications for each service and the application technique shall be as recommended by the manufacturer.

B. Fire Rating: All insulation shall have a composite (insulation, jacket or facing and adhesive used to adhere facing or jacket to insulation) fire and smoke hazard, as tested by ASTM E84, NFPA 255, and UL 723, not to exceed:

C. Flame Spread 25.

D. Smoke Developed 50.

E. Accessories: Accessories such as adhesives, mastics, tapes, and cements shall have the same component ratings as listed.

F. Labels: Label products and their shipping cartons indicating that flame spread and smoke developed ratings do not exceed the above requirements.

2.2 INSULATION THICKNESS:

A. Minimum: Insulation thickness shall not be less than the following:

<table>
<thead>
<tr>
<th>Piping Surface</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof and overflows drains (underside), horizontal downspouts, underside of drains (including traps) and horizontal</td>
<td>1-1/2”</td>
</tr>
<tr>
<td>Domestic hot water lines 2&quot; and smaller</td>
<td>1-1/2”</td>
</tr>
<tr>
<td>All otherwise uninsulated pipe exposed to outdoor temperatures</td>
<td>2-1/2”</td>
</tr>
</tbody>
</table>

2.3 ROOF DRAIN PIPING:

A. All horizontal runs of roof drain piping in the building, and the bottom of all roof drains shall be insulated and sealed to the roof. Insulation shall be as specified for domestic hot water. Vertical roof drain piping inside the building shall not be insulated.

2.4 DOMESTIC HOT WATER PIPING:

A. Fiberglass Pipe Insulation: Provide Schuller Micro-Lok AP/AP-T, Owens/Corning ASJ/SSL, Certain-Teed Snap-on ASJ/SSJ or an approved equal pre-formed glass fiber pipe insulation with a white all service jacket/vapor barrier. Glass fiber pipe insulation shall have a K factor of 0.23 at 75°F mean, a jacket tensile strength of 40 pounds per inch of width, a Mullen Burst of 70 psi, a Beach Puncture of 50 ounce inch per inch and a permeability of 0.02 perm. Longitudinal laps on refrigerant suction pipe insulation shall have a factory-applied pressure sensitive tape closure system. Three inch (3") wide factory-supplied pressure sensitive closure strips shall be provided for butt joints.
B. Fitting Insulation: Provide pre-molded rigid insulation for valves, fittings, flanges, strainers, and unions. Insulation shall be as specified for pipe insulation, except without the all-service jacket, where applicable.

C. Manufactured Fitting Covers: Provide matching 25/50 rated PVC covers for insulation on valves, fittings, flanges, strainers, and unions. Covers shall be sealed at cover lap joints and at lap joints to adjacent pipe insulation with an approved vapor barrier mastic. All circumferential joints shall be taped with Manville Z-tape or an approved equal. Covers shall be designed to allow strainer removal or flange removal without destruction of the insulation or cover.

D. Field Fitting Covers: Provide Foster 30-35 Tite-Fit coating or an approved equal set with Foster Mast-A-Fab or equal reinforcing mesh. Color shall be white unless noted otherwise.

E. PVC Jacketing: Provide pre-rolled protective jacketing where required or specified for protection of the insulation all service jacket. PVC jacketing shall be 30 mil thickness. All joints shall be made by lapping the jacket and sealing with an approved PVC welding adhesive.

F. Elastomeric Insulation: Provide Armstrong Type II "Armaflex" or approved equal closed cell elastomeric insulation. Insulation shall have a K factor of not more than 0.28 Btu/inch per degree F-per hour at 75° F mean temperature and a water vapor permeability of 0.15 perm-inch or less. Insulation shall have a flame spread rating of 25 and a smoke developed rating of 50. Provide manufacturers recommended adhesive (Armstrong 520 or Manville No. 57).

G. Lavatory Piping: Provide Truebro Model #102 or Plumberex PR0-2000 series or equal fully molded, flexible vinyl insulation system for insulating lavatory traps and hot and cold water supplies.

H. Miscellaneous: Provide all miscellaneous accessories, components and materials required for installation of a complete insulation system.

2.5 PROTECTIVE JACKETING:

A. Provide protective jacketing as described elsewhere and on all exterior piping.

B. Jacketing and fitting covers shall be .016 aluminum smooth as manufactured by Premetco or Childers. The jacket shall be pre-cut, pre-rolled, and lapped a minimum of two inches (2") In all directions to shed water. The metal shall be secured at each joint with a minimum of one each (1 ea.) ¾" wide .020 aluminum or stainless steel band and seal. The metal jacketing and fitting covers shall be fabricated of 0.016" aluminum or stainless steel with a smooth finish.
PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Install materials in accordance with manufacturer’s instructions in the absence of specific instruction herein.

B. On exposed piping, locate insulation and cover seams in least visible locations, but not higher than at the side of the pipe at the “90°” position, with the seam lapped such that the lap is directed down.

C. Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature: Vapor barriers are required. The vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.
   1. Provide vapor barrier jackets, factory applied or field applied.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.
   3. Finish with glass cloth and vapor barrier adhesive.

D. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.

E. For insulated pipes conveying fluids above ambient temperature:
   1. Provide standard jackets, with or without vapor barrier, factory applied or field applied.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
   3. If PVC fitting covers are used they shall have 25/50 rating.
   4. For hot piping conveying fluids 140°F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

3.03 INSERTS, SUPPORTS AND SHIELDS:

A. Application: Piping 2 inches diameter or larger for all systems except direct buried.

B. Shields: Install between pipe hangers or pipe hanger rolls and inserts. Hangers shall be on the outside of the insulation and shall not be in contact with the pipe. Curved metal shields shall be used between the hangers or support points and the bottom of the insulated pipe for Insulated pipes 2” and larger. Curved metal shields shall be designed to limit the bearing stress on the insulation to 35 psi and shall be curved to fit up to mid-perimeter of the insulated pipe. Shields shall be made of galvanized iron, or black iron painted on both sides with two coats of aluminum paint. Required metal shield sizes are as follows:
PIPING INSULATION

<table>
<thead>
<tr>
<th>Nominal IPS</th>
<th>Metal Thickness</th>
<th>Lengths of Shield</th>
</tr>
</thead>
<tbody>
<tr>
<td>up thru 2”</td>
<td>14 gauge</td>
<td>12”</td>
</tr>
<tr>
<td>thru 6”</td>
<td>12 gauge</td>
<td>16”</td>
</tr>
<tr>
<td>and above</td>
<td>10 gauge</td>
<td>20”</td>
</tr>
</tbody>
</table>

C. Insert Location: Between support shield and piping and under the finish jacket.

D. Insert Configuration: Minimum 2” inches longer than length of shield, of same thickness and contour as adjoining insulation; may be factory fabricated.

E. Insert Material: Heavy density insulating material suitable for the planned temperature range, and the weight of the pipe.

F. The shields at support points shall be secured with ½” x 0.016” stainless steel bands and seals.

G. Finish insulation at supports, protrusions, and interruptions.

H. The application of the protective shields at rack and guide points in tunnels and in central chilling stations shall be as detailed on the accompanying Drawings.

I. In lieu of the above the following system of support may be used:

1. At the pipe support positions, the insulation and vapor barrier shall be continuous and shall not be punctured by the support. The insulation at the support shall be the full circumference of 5lbs/ft3 Koolphen K Phenolic Foam material to withstand the bearing loads transmitted from the pipe to the support, it shall extend for at least 1” on either side of the support to allow sealing of the joints with the pipe insulation jacket.

2. The load bearing insulation at the support shall be capable of withstanding the maximum static compressive loads generated by pipe supported at the centers shown in Table 1.

Variations: Pipe loads greater than those generated at the support centers shown in Table 1 shall be referred to the manufacturer to establish the length and density of the insulated support block. The support centers are based on the weight of Sch 80 pipe filled with water and covered with 1” thickness of 2.2 lbs/ft3 standard insulation including FSK/ASJ vapor barrier.
Table 1 K Block Support Centers

<table>
<thead>
<tr>
<th>Nominal Pipe Size</th>
<th>3/4</th>
<th>1</th>
<th>1</th>
<th>2</th>
<th>2 1/2</th>
<th>3</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max support centers (feet)</td>
<td>6.5</td>
<td>6.5</td>
<td>6.5</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Sch 80 pipe filled with water covered with 1&quot; of Standard Insulation</td>
<td>6.5</td>
<td>6.5</td>
<td>6.5</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Metal Saddle Gauge (Galvanized Steel)</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>16</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Length of K Block (inches)</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

3. The Insulation at supports shall be a Kooltherm K Block. K Blocks shall be faced with factory applied FSK/ASJ vapor barrier and fitted with a galvanized steel 1800 saddle bonded to the bottom section of the K Block, for all pipe sizes 1 1/2" and larger.

4. The vapor barrier shall be completed by the use of a FSK/ASJ overlap and factory applied self-seal lap tape and sealed with vapor barrier adhesive.

5. At all support positions, other than those where the insulated pipe support block is surrounded by a clip or saddle in direct contact with the block, a block designed to accept the loads generated by the pipe shall be presented to the engineer for approval. e.g. Of the type Kooltherm Insulation products K Block. Ref:- Kooltherm sketch 106/2c for use with Roller or flat beam support.

6. In all cases where roller supports are used the length of the insulation and the wearing plate where fitted shall extend beyond the limits of the pipe movement.

J. For heat traced piping, insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

K. For purpose of definition in this Specification: “concealed” areas are those areas which cannot be seen by the building occupants, and “exposed” areas are all areas which are exposed to view by the building occupants, including under counter and inside cabinet areas, plus all mechanical rooms.

L. Self Sealing Lap and butt joints will not be acceptable as the only seal on piping insulation joints. Self Sealing Lap and butt joints may be utilized only if the joints are additionally secured with field applied vapor barrier adhesive (on piping Systems requiring vapor barriers) or staples and field applied adhesive (on piping system which do not require a vapor barrier jacket). Mechanical fasteners shall be used whenever possible to assure permanent installation.
M. Insulation minimum thickness shall be as scheduled; however, additional thickness shall be provided to prevent condensation on the cold surfaces and to provide a maximum exterior insulation surface of 140°F on the hot surfaces.

N. All exposed outdoor piping shall have metal jacket.

O. Fitting insulation shall be applied in same manner as pipe application. Protruding metal parts (such as valve stems) shall be completely sealed off. Fitting cover jacketing shall be equal to Gasco, Pabco or RPR Metals prefabricated fitting covers of 0.016” paper coated aluminum, secured as recommended by the manufacturer.

P. Valves, fittings, etc., in congested areas around coil and heat exchanger equipment, etc., shall be insulated by building up fitting segments and pre-molded sections as necessary.

Q. No pipe supporting device (other than guides or anchors attached directly to the pipe) shall penetrate the insulation.

3.04 PAINTING:

A. All exposed insulation shall be prepared to receive painting specified.

B. The pipe primer shall be Pittsburgh Corning Corporation Pittcote 300.

3.05 INSULATION THICKNESS:

<table>
<thead>
<tr>
<th>Temp</th>
<th>Oper</th>
<th>‘k’ @</th>
<th>Min. R value for each Pipe Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td></td>
<td>1”</td>
</tr>
<tr>
<td></td>
<td>Temp °F</td>
<td></td>
<td>to 2”</td>
</tr>
<tr>
<td>Hot (1)</td>
<td>105-140</td>
<td>.26 @ 100</td>
<td>3.8</td>
</tr>
<tr>
<td>Cold (2)</td>
<td>40-55</td>
<td>.25 @ 75</td>
<td>2.0</td>
</tr>
</tbody>
</table>

A. No chilled water insulation shall be less than 2” thick. No chilled water insulation on pipe larger than 2” shall be less than 2”.

B. Minimum ‘R’ does not consider water vapor transmission and condensation. Additional insulation and/or vapor retarders may be required to limit water vapor transmission and condensation under extreme conditions.

C. A minus 15 percent tolerance, on the insulation performance listed shall be permitted for manufacturers’ standard insulation systems.

END OF SECTION 230719
SECTION 232000
HVAC PIPING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions,
Supplementary General Conditions, all applicable requirements of Division 1, "General Requirements",
and Section 230000, "Basic Mechanical Requirements", govern this Section.

1.2 DESCRIPTION OF WORK:
A. Work Included: Provide complete operating HVAC piping systems including pipe, tube, fittings, and
appurtenances as indicated and in compliance with these Specifications.
B. Applications: Applications of piping systems include, but are not limited to, the systems as listed below:

<table>
<thead>
<tr>
<th>System</th>
<th>Working Pressure</th>
<th>Operating Temperatures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condensate Drainage</td>
<td>--</td>
<td>40°F to 60°F</td>
</tr>
<tr>
<td>Refrigerant</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

C. Basic Materials and Methods: Refer to Section 23 03 00, "Basic Materials and Methods", for additional
HVAC piping system requirements.
D. Valves and Accessories: Refer to Section 23 20 10, "HVAC Piping Valves and Accessories", for
additional HVAC piping system components.
E. Vibration Isolation: Refer to Section 23 05 48, "Vibration Isolation", for piping system isolation.
F. Insulation: Refer to Section 23 07 00, "System Insulation", for piping system insulation.

1.3 QUALITY ASSURANCE:
A. Welding: Qualify welding procedures, welders, and operators in accordance with ANSI B31.1,
Paragraph 127.5, for shop and job site welding of piping work. Make welded joints on the piping
system with continuous welds, without backing rings and with pipe ends beveled before welding. Gas
cuts shall be true and free from burned metal. Before welding, surfaces shall be thoroughly cleaned.
The piping shall be carefully aligned and no weld metal shall project inside the pipe.

1.4 SUBMITTALS:
A. Shop drawing submittals shall include, but not be limited to, the following:
   1. Cut sheets marked to clearly indicate all HVAC piping system materials.
   2. Piping fabrication drawings for all main piping runs. Fabrication drawings shall include plan views
      and suitable elevations and shall include all accessories and equipment.
   3. Pipe fabrication drawings for all pre-insulated underground piping showing location and sizes of
      all expansion/contraction loops, thrust block location, anchors and guides. Manufacturer shall
      provide detailed drawings and calculations for review by the Engineer prior to fabrication and
      installation of systems.
4. Pipe fabrication drawings and cutsheets for all refrigerant piping showing all specified fittings and accessories, pipe lengths and pipe sizes. Submit line sizing calculations approved by compressor unit manufacturer's application engineering department prior to installation of systems.

5. Additional items as required in Section 23 01 00.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver components in factory-fabricated water-resistant packaging, as applicable.

B. Handle components carefully to avoid damage to components, enclosures, and finish.

C. Store components in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS:

A. General: Provide pipe and tube of type, joint, grade, size, and weight (wall thickness, schedule or class) indicated for each service. Comply with applicable governing regulations and industry standards.

1. Copper Tube: ASTM B88, Types "K", Type "L", or Type "M" copper water tube as defined by the Copper and Brass Research Association.

2.2 PIPE/TUBE FITTINGS:

A. General: Provide factory-fabricated fittings of type, materials, grade, class, and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve, and equipment connections. Where not otherwise indicated, comply with governing regulations, industry standards, and where applicable, with pipe manufacturer's instructions for selections.

1. Cast Iron Flanged Fittings: ANSI B16.1, Class 125 or Class 250, black including bolting and gasketing.


3. Malleable Iron Threaded Unions: ANSI B16.39, select for proper piping fabrication and service requirements including style, end connections, and metal-to-metal seats (iron, bronze, or brass), plain or as specified.


5. Steel Flanges/Fittings: ANSI B16.5 and B16.9, including bolting, gasketing, and butt weld end connections.


8. Pipe Nipples: Fabricated from same pipe as used for connected pipe, except do not use less than Schedule 80 pipe where length remaining unthreaded is less than 1/2". Do not thread nipples full length (no all-thread nipples).

B. Miscellaneous Piping Materials/Products:

1. **Welding Materials**: Comply with ASME Boiler and Pressure Vessels Code, Section II, Part C, for welding materials.


3. **Insulating (Dielectric) Unions**: Provide dielectric unions at all pipe connections between ferrous and nonferrous piping. Unions shall be "Delvin" as made by Pipeline Seal and Insulator Company or "EPCO" as made by Epco Sales, Inc. and shall have nylon insulation, or "Clearflow" waterway by Victaulic.

4. **Solder**: All solder used for sweating of joints shall be 95/5 tin-antimony or tin-silver.

5. **Threadsealing Tape**: Threadsealing tape used for chilled and hot water applications up to 150 psi shall be stretched or nonstretched teflon tape. Threadsealing tape used for chilled and hot water applications over 150 psi and all steam applications shall be nonstretched 0.003" thick teflon tape and shall be color-coded for identification.

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**PART 3 - EXECUTION**

3.1 **PIPING INSTALLATION:**

A. **General:**

1. **Industry Practices**: Install pipe, tube, and fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without failure or degradation of service. Install each run with a minimum of joints and couplings, but with adequate and accessible unions or flanged connections to permit disassembly for maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align accurately at connections, within 1/16" misalignment tolerance. Coordinate piping locations with other trades to avoid conflict. Give ductwork preference unless directed otherwise by the Engineer.

2. **Systems**: Install piping parallel or perpendicular to lines of building, true to line and grade, and with sufficient hangers to prevent sags between hangers. Provide fittings at changes in direction. Piping in finished areas shall be concealed, except in mechanical rooms. Where pipes of different sizes join, provide reducing elbows, tees, or couplings. Bushings will not be acceptable.

3. **Expansion and Contraction**: Install anchors, loops, offsets, sizing joints, and expansion joints, as necessary, to avoid strain resulting from expansion and contraction of piping systems on fixtures and equipment.

   a. **Expansion Loops and Offsets**: Provide expansion loops and offsets in piping systems for not less than one inch (1") expansion or contraction per 100' of pipe.

   b. **Mechanical Grooved Couplings**: Provide mechanical grooved connections where indicated on the Drawings and Specifications to reduce vibration at equipment connections. Provide expansion joints in piping systems by mechanical grooved connections where specifically indicated on the Drawings.

B. **Steel Pipe**: Ream steel pipe after cutting and before threading. Thread with clean-cut taper threads of length to engage all threads in fittings and leave no full-cut threads exposed after make-up. Use John Crane, or approved equal, or teflon thread tape applied only to male threads to make-up joints.

C. **Copper Pipe**: Cut copper pipe square and ream to remove burrs. Clean fitting socket and pipe ends with sand cloth, No. 00 cleaning pads or wire brush.
D. Final Connections to Equipment Furnished by Owner or Under Other Divisions of These Specifications: Where Drawings show equipment to be furnished under other Divisions of these Specifications or by the Owner, such equipment will be delivered to the site, uncrated, assembled, and set in-place under those other Divisions of these Specifications or under the separate contracts. Any required automatic control valves shall also be provided under those other Divisions of these Specifications or other separate contracts. Make all final connections of chilled water, hot water, and condenser water as shown. Provide valves, unions, strainers, check valves, and traps as required for proper operation of systems and equipment. Equipment not shown or noted on the piping drawings shall not be included in the scope of this requirement.

E. Excavation, Installation and Backfill for Underground Pipe:

1. **Layout:** Pipes shall be laid and pipe joints made in presence of the Architect and field measurements, layouts, batter board alignment, grade establishments, and similar locations shall be performed by a Professional Engineer in the employ of the Contractor. The Contractor's engineer shall be on the job during all underground work. A "Bench-Mark" reference for use by the Contractor shall be provided by the Architect.

2. **Pipe Grading:** Lay and maintain all pipes at required lines and grades during the course of the Work to comply with the Drawings.

3. **Trench:** Excavate the trench to the depth required. Properly brace and dewater the trench and keep it free of water during installation, testing pipe, and backfilling. No water shall be discharged onto the street or freeway without approval by the Architect. Refer to Section 23 03 00 for additional requirements.

4. **Excavation:** The trench shall be at least 18" wider than the maximum diameter of the pipe and the pipe shall be laid in the center of the trench. The trench shall be excavated to a depth sufficient to provide for pipe cushions or supports as specified. Trench width may be increased as required and piling left in place until sufficient compacted backfill is in place. Properly sheet and brace all open trenches to render them secure and remove all such sheeting and bracing before completing the backfill. Comply with local regulations or, in the absence thereof, with the "Manual of Accident Prevention in Construction" of the Associated General Contractors of America, Inc. The quantity of excavation required to install sheeting and the installation and removal of sheetings and bracings will not be regarded as Extra Work. All costs incurred for this excavation and the installation of sheeting shall be included in the Contract Price. Refer to Section 23 03 00 for additional requirements.

5. **Grading:** Upon completion of excavation and prior to the laying of the pipe, the trench bottom shall be brought up to the required elevation with a pipe cushion, except where the cushion has been eliminated by the Engineer. Pipe cushions shall be select material deposited in the trench and shall be compacted, leveled off, and shaped to obtain a smooth compacted bed along the laying length of the pipe. Pipe cushion material shall comply with local codes. In absence of local code requirements, the cushion shall be bank sand or select backfill material approved by the Architect. Any material used shall pass a one inch (1") screen.

a. **Stable, Firm Semi-dry Trench:** Piping shall be laid on undisturbed earth, in a constant uniformly sloped trench. Laying space for mechanical joints shall be hand cut to 6" either side of the joint and stabilized sand poured and wet in to even with the natural earth trench bottom. The pressure test of the piping system shall be inspected by the Owner's Representative prior to covering the piping. Failure to notify the Owner's Representative for inspection prior to covering the piping will result in the piping being uncovered and the test being performed again. Where the slope of the trench is found to belly down along the line of piping, before joining, the pipe shall be removed from the trench and the belly converted to
uniform slope by adding stabilized bank sand, wet down and slightly mounded to the center of the trench. The section of piping will then be "rolled" into place so with support uniform along its entire length. Where the slope of the trench is found to arch up along the line of piping, before joining, the pipe shall be removed from the trench and the arch converted to uniform slope by cutting the arch out. The section of piping will then be reset into place with support uniform along its entire length.

b. **Wet Clay - Black Gumbo:** Piping shall be laid in a constant, uniformly sloped trench. After shaping, the trench shall receive 3" minimum clean bedding sand, which shall be uniformly distributed on the trench bottom. Laying space for the mechanical joints shall then be hand removed and the piping placed on the setting bed with the weight of the piping distributed evenly on the setting bed over its entire length. The pressure test of the piping system shall be inspected by the Owner's Representative prior to covering the piping. Failure to notify the Owner's Representative for inspection prior to covering the piping will result in the piping being uncovered and the test performed again.

c. **Rock:** Where rock is encountered, the trench shall be excavated to a minimum of 6" below the pipe elevation and then backfilled with bedding sand to provide a uniform layer for pipe support. Backfill shall be as indicated for Wet Clay - Black Gumbo.

d. **Special Considerations:** Where the expansive soil conditions on the site, special precautions shall be taken to prevent pushing and breakage of underground piping. Precautions shall be in accordance with local installation techniques and may include carton forms or special pipe bedding. Installation methods shall comply with preinsulated piping system manufacturer's requirements where applicable.

6. **Anchors:** Pipes shall have concrete anchors/thrust blocks at each change in direction and/or as directed. Any change in direction exceeding 15 degrees shall be anchored. Concrete anchors shall rest against solid (virgin) ground with the required area of bearing on pipe and ground to provide suitable anchoring.

7. **Backfill:** Backfill trenches only after piping has been inspected, tested, and approved by the Architect. Place backfill material in the trench either by hand or approved mechanical methods. The compaction of backfill material shall be accompanied by tamping with hand tools or approved pneumatic tampers, by using vibratory compactors, by puddling, or by any combination of the three. The method of compaction shall be approved and all compaction shall be done to the satisfaction of the Architect. Backfill completely around pipe, including 18" above the pipe, with suitable bank sand, tamped in 4" layers under, around, and over pipe. Water down backfill as required. The remainder of the backfill for pipes shall be select backfill material tamped at intervals of no more than 12" depths, to attain a 95% Proctor Compaction Density. All materials to be used as select material backfill shall be approved by the Architect. If, in the opinion of the Architect, the excavated material does not meet the requirements of select material, the Contractor shall be required to screen the material prior to its use as select material backfill. Material used in the upper portion of the backfill or subgrade shall not contain stone, rock, or other material larger than 6" in its longest dimension. No wood, vegetable matter, or other material, which in the opinion of the Architect is unsuitable, shall be included in the backfill. The upper 24" of backfill may be water jetted, if desired. Bring backfill up to finish grade identified on the Architectural Drawings, including additional backfill required to offset settlement during consolidation. When removal of unsuitable, excavated material creates a shortage of backfill material, the Contractor shall, at no change in Contract amount, furnish material as specified in this Section in the amount required to complete the backfill.

8. **Existing Surfaces:** Restore existing streets, driveways, and sidewalks damaged during the excavation work to acceptable condition, subject to approval by the Architect.
9. Safety: Provide street and sidewalk excavations with approved barricades, warning lights, and cover plates as required by the City. Refer to Section 23 03 00 and Division 1 for additional requirements.

F. Pipe Fabrication Drawings:
1. Pipe fabrication drawings shall be submitted for all piping in the Central Plant, [Utility Tunnel,] Mechanical Rooms, Penthouse and for equipment connections and all other areas requiring coordination with other trades.

2. Pipe fabrication drawings shall be double line drawings to scale on 1/4" scale building floor plans and shall indicate pipe size, fittings, valves, accessories, connections, system type, insulation, support requirements, pipe elevations and other information required for coordination with other trades and fabrication of pipings.

3. Pipe fabrication drawings shall be coordinated with other trades and building construction prior to submittal for approval. Refer to Section 23 01 00 for additional shop drawing requirements.

G. Basic Materials and Methods: Refer to Section 23 03 00 for additional requirements related to HVAC piping.

3.2 CONDENSATE DRAINAGE:
A. General: Drain piping shall be provided from each air handling unit, fan coil unit, water chilling unit, heat exchanger, pump base drain, vessel overflow, auxiliary drain pan, piping system drain, and elsewhere where drains are required and shall extend to the nearest floor drain, hub drain or condensate drainage system. Drains shall be sized as indicated but not less than the drain connection size. Air handling unit and fan coil unit drains shall have deep seal traps at each blow-through or draw-through unit to maintain water seal. Provide cleanouts on each change of direction on deep seal traps.

B. Drain piping shall be fabricated of Schedule 40 galvanized steel pipe and threaded fittings or Type "L" hard drawn copper tubing and wrought copper solder type fittings.

C. Drain piping exposed on the roof shall be painted to match the roof color.

3.3 REFRIGERANT PIPING:
A. General: Refrigerant piping shall be fabricated of Type L hard drawn "ACR" tubing that has been cleaned and capped for refrigeration service. Fittings shall be wrought copper and shall be installed with silver solder joints. The end of all pipe and the inside of all fittings shall be carefully cleaned before joining. No acid shall be used in cleaning or as a flux in soldering joints. Bleed nitrogen through all piping while soldering.

B. Furnish, size, install and insulate refrigerant pipe for the system as shown. Submit Shop Drawings of piping system showing all traps, pipe sizes, and accessories. Drawings to be marked "Approved", and signed by a representative of the Application Engineering Department of the condensing unit manufacturer. Pipe sizes to be as recommended by unit manufacturer. Submit line sizing calculations for review by Engineer.

C. Provide replaceable core type liquid line filter dryer sized for system capacity at 2 psig pressure drop per ARI Standard 710, sight glass-moisture indicator, thermal expansion valve with adjustable superheat, refrigerant shutoff, relief and solenoid valves recommended by the equipment manufacturer.

D. Install and insulate all refrigerant piping per unit manufacturers latest published recommendations. Slope all lines to facilitate oil return to compressor. Provide suction line traps per manufacturers recommendations. Refrigerant piping shall be installed as shown except that modification shall be
made as recommended by the compressor manufacturer. Such modifications shall be made at no cost to the Owner.

E. Test and dehydrate all refrigerant piping as specified hereinbelow.

F. After dehydration, introduce the manufacturers recommended type and quantity of refrigerant into system through a filter/dryer.

3.4 CLEANING, FLUSHING, TESTING AND INSPECTING:

A. Cleaning: Clean exterior surfaces of installed piping systems and prepare surface for application of any required coatings.

B. Piping Tests:

1. General: Blank off equipment during tests. Perform tests before piping is enclosed in walls, floors, partitions or in any other way concealed from view. Tests may be performed in sections. Tests shall be witnessed by the Engineer and local inspectors and results presented to the Engineer for acceptance and approval prior to concealing piping from view. Provide all necessary equipment for testing, including pumps and gauges. Refer to Section 23 05 93 for additional requirements.

2. Condensate Drainage System: Test condensate drainage piping by plugging all openings and filling system to height of 10' above the level of the pipe being tested, for a minimum of 4 hours. Inspect all joints for leaks, repair all leaks found, and retest until piping is demonstrated to be free from leaks as evidenced by no perceptible lowering of the water level after 4 hours.

3. Refrigerant Piping System: After completion of the refrigerant piping system and before charging, test the system with dry carbon dioxide at 250 psig for 24 hours. Test joints under pressure with soap solution. During the test, isolate expansion valves and other auxiliary devices to prevent damage due to high pressure.

   a. After the initial pressure test has been completed and the system proved tight, introduce a mixture of refrigerant and dry carbon dioxide into the system at 150 psig and test all devices and fittings for leaks using a halide torch.

   b. Following the satisfactory completion of all tests, evacuate the system by means of a vacuum pump connected to the liquid line. After 20" of vacuum is obtained, close the suction and discharge valves at the compressor and continue evacuation for 24 hours. Vacuum shall be measured with a mercury column vacuum gauge.

C. Inspecting: Visually inspect each run of each system for completion of joints, adequate hangers, supports, and inclusion of accessories and appurtenances.

D. Chemical Treating: Refer to Section 23 50 00, "Water Treatment Systems", for flushing and cleaning systems.

3.5 IDENTIFICATION:

A. Refer to Section 23 03 00 for applicable painting, nameplates, and labeling requirements.

END OF SECTION 23 20 00
SECTION 233113

DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 23 01 00, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

A. **Work Included:** Provide metal ductwork systems as shown on the Drawings and as specified herein.

B. **System Types:** The types of ductwork systems specified in this Section include, but are not necessarily limited to the following:
   1. Air conditioning supply and return air systems.
   2. Outdoor air supply systems.
   3. Mechanical exhaust systems.
   4. Exposed Double Wall Duct systems.

C. **Constant Volume Supply Air Ductwork:** Ductwork shall be sheet metal ductwork designed for velocities up to 2500 fpm and pressures up to +2" wg. Ductwork shall be externally insulated.

D. **Outside Air Ductwork:** Ductwork shall be sheet metal ductwork designed for velocities up to 2500 fpm and pressures up to +3" wg. Ductwork shall be externally insulated.

E. **Return Air Ductwork:** Ductwork shall be sheet metal ductwork designed for velocities up to 2500 fpm and pressures up to -1" wg. Ductwork used for return air boots and elbows and other return air ductwork where shown on the Drawings shall be lined with one inch (1") ductliner.

F. **General Exhaust Ductwork:** General exhaust ductwork shall include all exhaust ductwork which is not otherwise specified. Ductwork shall be sheet metal ductwork designed for velocities up to 2500 fpm and pressures up to -2" wg. General exhaust duct shall be uninsulated, except that exhaust ductwork which passes through nonconditioned spaces shall be externally insulated and horizontal exhaust ductwork from/in toilets shall be lined with one inch (1") ductliner.

G. **Flexible Ductwork:** Ductwork connections to HVAC terminal units and air devices shall be made with flexible ductwork connection where shown on the Drawings. Additional connections may be made using flexible ductwork at the Contractors option, where approved in writing, in advance, by the Engineer.

H. **Ductwrap Insulation:** Refer to Section 23 07 00, System Insulation*, for external ductwrap insulation.

I. **Ductwork Accessories:** Refer to Section 23 31 14, "Ductwork Accessories", for accessories and specialties related to ductwork systems and installation.

J. **Basic Materials and Methods:** Refer to Section 23 03 00, "Basic Materials and Methods", for basic materials and methods related to mechanical construction.
1.3 QUALITY ASSURANCE:

A. SMACNA Standards: Comply with Sheet Metal and Air Conditioning Contractors National Association (SMACNA), HVAC Duct Construction Standards, Metal and Flexible, 1985 Edition recommendations for fabrication, construction, details, and installation procedures, except as otherwise indicated on the Drawings or in these Specifications.

B. ASHRAE Standards: Comply with American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standards and recommendations, except as otherwise indicated on the Drawings or in these Specifications.

1.4 SUBMITTALS:

A. Shop Drawing submittals shall include, but not be limited to, the following:

1. Ductwork submittals shall include ductwork fabrication drawings and submittal data on ductwork specialties and construction details.

2. Ductwork fabrication drawings shall be drawings to scale on 1/4" scale building floor plans and shall indicate duct sizes, duct material, duct insulation type, locations of transverse joints, fittings, ductwork bottom elevation, offsets, ductwork specialties, flexible connections, flexible ductwork, fire and fire/smoke dampers and all other information required for coordination with other trades and fabrication of ductwork. All fire and fire/smoke partitions shall be clearly designated on the ductwork shop drawings. Ductwork fabrication drawings shall be coordinated with other trades and building construction prior to submittal for approval.

3. Duct specialties and construction details including, but not limited to information on duct construction and materials, transverse and longitudinal joints, cross-breaking or transverse beading, dampers, flexible connectors, fittings, transitions, elbows, control, fire and fire/smoke damper connections, branch taps, turning vanes, access doors and other required duct specialties and construction details.

4. Cut sheets on flexible ductwork and related taps and accessories.

5. Cut sheets on breeching and flue piping materials and accessories, including a complete flue design layout.

6. Duct system leakage test procedures and reporting forms.

7. Additional information as required in Section 23 01 00.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver ductwork materials to the site in suitable packaging to prevent damage and exposure to weather.

B. Store ductwork in dry areas, where it is not exposed to damage. Crib stored ductwork off of floors to prevent water damage.

C. Handle ductwork to prevent damage.

PART 2 - PRODUCTS

2.1 DUCTWORK MATERIALS:
A. **Sheet Metal:** Ductwork shall be constructed using prime G90 galvanized lock-forming quality or coil steel in widths up to 60”, conforming to ASTM A924/A924M-74, A653 and A653M and using gauges selected by application, based upon applicable SMACNA Standards.

B. **Labeling:** Ductwork materials shall be stenciled on maximum 10’ centers with the manufacturer’s name and material gauge. Stenciling shall be visible after duct is fabricated and installed.

C. **Exposed Ductwork Materials:** Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains, discolorations, and other imperfections, including those which would impair painting.

2.2 **MISCELLANEOUS DUCTWORK MATERIALS:**

A. **General:** Provide miscellaneous materials and products of the types and sizes indicated and where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.

B. **Duct Sealant:** Provide nonhardening, nonmigrating mastic or liquid elastic sealant (type applicable for the fabrication/installation detail) as compounded and recommended by the manufacturer specifically for sealing joints and seams in ductwork. Sealers shall be as follows:

1. Sealer shall have a high solids content.
2. Sealer shall have a high adhesive and cohesive strength and shall bond to both degreased and non-degreased metals.
3. Sealer shall conform to NFPA 90-A requirements and be UL-labeled for ductwork applications.
4. Sealer and related installation materials and methods shall be:
   a. Hardcast Type 601 Iron Grip Duct Sealant.
   b. United McGill Corporation United Duct Sealer.
   c. Foster Type 30-02 High Velocity Duct Seal.
   d. Transcontinental Equipment Ltd. Multipurpose Water Based Duct Sealer.

C. **Exposed Stainless Steel:** Provide matching stainless steel supports for exposed stainless steel ductwork.

D. **Ducretliner:**

2.3 **Ductliner:**

A. **Acoustical Ductliner:** Provide Schuller Permacote Linacoustic Standard/HP or Owens-Corning Aeroflex 1” thick fiberglass ductliner with an NCR of 0.55 or greater per ASTM C1071, a thermal conductivity of 0.31 BTU in/(hr ft² °F) and friction correction factor no greater than 1.02 at 500 fpm. All ductliner shall be guaranteed against delamination up to 3000 fpm velocities. Ductliner shall be have a surface coating formulated with an immobilized, EPA-registered, anti-microbial agent so it will not support the growth of fungus or bacteria.

B. **Ductliner Adhesive:** Provide non-flammable adhesives 3M #37, St. Clair R41B, Foster 85-11 or Foster 85-20, which comply with NFPA 90A and ASC-A-7001 by The Adhesive and Sealant Council, Inc. (see SMACNA standards).

C. **Ductliner Fasteners:** Comply with SMACNA requirements.
2.4 FLEXIBLE DUCT:

A. **General**: Insulated flexible duct shall be a factory fabricated assembly consisting of an inner liner, fiberglass insulation and a vapor barrier outer jacket.

B. **Inner Liner**: The inner liner shall consist of a galvanized steel helix mechanically securing an inner liner composed of a tri-laminate of aluminum foil, fiberglass and aluminized polyester for applications upstream of HVAC terminal units and shall consist of a galvanized steel helix mechanically securing an inner liner composed of a SPUNBOND nylon fabric for applications downstream of HVAC terminal units.

C. **Insulation**: Duct liner shall be wrapped with a nominal one inch (1") thick fiberglass insulation blanket with a maximum thermal conductance C Factor of 0.23 Btu/hr/sf/°F.

D. **Outer Jacket**: Insulation shall be covered with a reinforced metallic aluminum vapor barrier jacket with a maximum permeability of 0.05 Perm per ASTM E96, Procedure A.

E. **Pressure Ratings**: Flexible duct for applications upstream of HVAC terminal units shall be rated for a minimum of 12" positive and 5" negative internal working pressure. Flexible duct for air device applications shall be rated for 6" positive and 4" negative internal working pressure. Flexible duct shall be suitable for operation at temperatures up to 120°F.

F. **Sound Attenuation**: Flexible duct for air device applications shall be designed to provide sound attenuation and a 9’ length of 8” duct shall have typical insertion losses (IL), in dB, as follows:

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<thead>
<tr>
<th>Octave Band</th>
<th>2</th>
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<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<tbody>
<tr>
<td>Straight Duct at 2500 fpm flow</td>
<td>9</td>
<td>27</td>
<td>27</td>
<td>32</td>
<td>33</td>
<td>37</td>
</tr>
<tr>
<td>90° Bend Duct at 2500 fpm flow</td>
<td>18</td>
<td>31</td>
<td>34</td>
<td>37</td>
<td>34</td>
<td>38</td>
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G. **Codes/Standards**: Flexible duct shall be listed as Class 1 Air Duct per UL 181 and shall comply with NFPA 90A and 90B.

H. **Fire Ratings**: Flexible duct shall have a flame spread rating of less than 25 and a smoke developed rating of less than 50.

I. **Clamps**: Terminal unit flexible duct inner liner shall be secured using Flexmaster LS Series or approved equal 1/2” wide positive locking stainless steel straps. Air device flexible duct outer jackets shall be secured using Panduit Corporation, Ideal or an approved equal 0.35” wide self-locking nylon straps.

J. **Terminal Unit Flexible Duct Taps**: All take-offs for HVAC terminal units shall be conical bellmouth taps equal to a Flexmaster CB conical bellmouth fitting, or side take offs without dampers equal to a Flexmaster 45° STO fittings. Fittings shall be minimum 26 ga. Galvanized sheetmetal.

K. **Air Device Flexible Duct Taps**: All round take-offs for air devices shall be made with a damper spin-collor, equal to a Flexmaster FLD dampered spin fitting. Where the duct height does not allow the use of a spin-in fitting, use 45° STOD side take offs with dampers, equal to Flexmaster 45° STOD STOD Fittings. Dampers shall be provided with full length 3/8” square shafts secured to the damper blade with a minimum of 2 U-bolts, nylon bearings, insulation build out, heavy duty locking hand quadrants and integral flexible duct retention beads. Fittings and damper blades shall be minimum 26 ga. galvanized sheetmetal for sizes up to 10” and minimum 24 ga. galvanized sheetmetal for sizes up to 12” and larger.

L. **Manufacturers**: Flexible duct for applications upstream of HVAC terminal units shall be Flexmaster Type 3M or an approved equal. Flexible duct for air device applications shall be Flexmaster Type 6M Acoustical or an approved equal.

2.5 EXPOSED DUCT:
A. **General:** Medium/Low pressure duct located in exposed areas (as noted on the drawings) shall be double-walled round/rectangular ductwork. Ductwork shall be as manufactured by United McGill model K-27. The ductwork shall be lined with 2" insulation and a perforated inner liner. Construction shall be for TDC flange or Pittsburgh Lockseam. Ductwork shall be of galvanized steel for both outer shell and inner liner. Ductwork shall have paint grip for ease of painting. Paint shall be as directed by architect.

PART 3 - EXECUTION

3.1 **GENERAL REQUIREMENTS:**


B. Route all duct tight to underside of structure, unless otherwise noted or required for coordination. All ductwork shall be top level with bottom and side transitions only. The Mechanical Contractor shall be held responsible for coordinating with all other trades prior to the construction or installation of ductwork. Some ductwork may require the use of S-drive joints, flat seams or offsets to allow installation of other ducts or equipment. Use 45 degree radius elbows (center line radius 1.5 times duct height) to rise up and drop down when crossing ductwork or other material. The Mechanical Contractor shall be responsible for coordination of all such work with the General Contractor and other Subcontractors as required. Minimum bottom of duct elevation above finished floor shall be as noted on the Drawings, where applicable.

C. Adhere to the Drawings for routing and location of ductwork as closely as possible. Ductwork shop drawings shall be made after job site measurements are made and shall be coordinated with all other trade. Ductwork construction details and materials shall be submitted and approved prior to fabrication of any ductwork.

D. All ductwork shown on the Drawings, specified or required for the heating, ventilating and air conditioning systems shall be constructed and erected in a first class workmanlike manner. The work shall be guaranteed for a period of one year from and after the date of acceptance of the job against noise, chatter, whistling, vibration, and free from pulsation under all conditions of operation. After the system is in operation, should these defects occur, they shall be corrected as directed by the Engineer.

E. The interior surface of all ductwork shall be smooth with no parts projecting into the air stream unless specified to do so. All seams and joints shall be external. The inside of all ductwork shall be thoroughly cleaned and all fans operated to remove any debris prior to connection of air devices.

F. All holes in ducts for damper rods and other necessary devices shall be either drilled or machine punched (not pin punched), and shall not be any larger than necessary. All duct openings shall be provided with sheet metal caps if the openings are to be left unconnected for any length of time.

G. Where ducts, exposed to view (including equipment rooms), pass through walls, floors or ceilings, furnish and install sheet metal collars around the duct.

H. When the Mechanical Contractor submits revised duct sizes for review by the Engineer or requests to substitute rectangular, round or flat oval duct sizes for rectangular, round or flat oval spiral duct, substitute sizes shall be based on equivalent hydraulic diameter as calculated by ASHRAE formulae for equivalent friction loss and airflow.

I. Sheet metal plenums shall be constructed and reinforced in accordance with SMACNA standards. Where plenums are connected to louvers, the plenum bottom shall be sloped to drain to the louver.
J. Ductwork which is exposed to weather shall have soldered joints and seams and shall be painted with a suitable epoxy coating.

3.2 COORDINATION:

A. Prior to submitting ductwork shop drawings, the Division 23 Contractor shall fully coordinate the routing and height of all ductwork with all other trades and with ceiling heights, lighting fixtures and building construction. Where ductwork is concealed, bottom of duct shall be a minimum of 8" above the ceiling unless otherwise noted. Where ductwork is exposed, bottom of horizontal duct shall be a minimum of 6'-6" above finished floor. Where ductwork is exposed in occupied areas it shall be tight to the structure and the bottom of the duct shall be minimum 6'-6" above finished floor.

3.3 GENERAL DUCTWORK FABRICATION:

A. Duct Gauge and Reinforcing:

1. Rectangular Ductwork: Minimum metal gauges and reinforcement shall be in accordance with SMACNA HVAC Duct Construction Standards (SDCS) Tables 1-3 through 1-13. Minimum aluminum gauges and reinforcement shall be in accordance with SDCS Tables 1-14 through 1-16. Reinforcing shall be installed per SDCS Fig. 1-9 through 1-12.

2. Round Ductwork: Minimum metal gauges for longitudinal and spiral seam round ductwork shall be in accordance with SDCS Table 3-2. Minimum aluminum gauges for longitudinal and spiral seam round ductwork shall be in accordance with SDCS Table 3-3. Longitudinal seam ductwork larger than 12" diameter shall not be permitted unless welded seams are used.

3. Cross-breaking: Cross-break or transverse bead all flat surfaces which are more than 12" wide. Transverse beading shall be on 12" centers and shall be a minimum of 1/8" deep at the center of the bead and 3/8" wide at the base of the bead.

4. Minimum Gauges: The metal gauges listed in the SDCS for round and rectangular ductwork are the minimum recommended. It shall be the Contractor's responsibility to select a metal gauge heavy enough to withstand the physical abuse of installation.

B. Duct Joints And Seams:

1. General: Make all joints airtight. The distance between transverse joints on any size duct shall not exceed 5'.

2. Rectangular Ductwork: Transverse joints and longitudinal seams in ductwork shall be constructed in accordance with SDCS Fig. 1-4 and 1-5. Drive slips may be used on rectangular ductwork on short sides only, up to 18" maximum. Gauge of drive slips shall be at least as heavy as ductwork on which they are installed. Bend drive slips over at least 3/4" at corners. Corner closures shall be in accordance with SDCS Fig. 1-13 through 1-18. All longitudinal seams shall be "Pittsburgh Lock" or button punch snap lock at corner seams and grooved seam or seam welded in sides between corners, in accordance with SDCS Fig. 1-5. At the Contractor's option, transverse joints may be transverse duct flange joints or Ductmate EP12/11 prefabricated galvanized "Ductmate" sections. The proposed gasket material, flange, corner piece and Ductmate details shall be submitted for approval.

3. Round Ductwork: Transverse joints for round ductwork shall be beaded sleeve type constructed in accordance with SDCS Fig. 3-2, properly secured and sealed. Draw bands shall not be used on round ductwork. Longitudinal and spiral seams shall be constructed in accordance with SDCS Fig. 3-1.

4. Ductwork Sealing: Seal all longitudinal and transverse ductwork joints and seams using SMACNA ductwork sealant and 3" wide open weave tape to provide positive seal. Sufficient sealant shall be used to completely imbed the cloth.
C. **Connections and Take-offs:**

1. **Rectangular Ductwork:** Parallel flow branches shall be constructed using radius elbow take-offs in accordance with SDCS Fig. 2-7. Branch duct connections shall be 45 degree entry expanded taps constructed in accordance with SDCS Fig. 2-8. Duct-mounted coil connections shall be constructed in accordance with SDCS Fig. 2-11.

2. **Round Ductwork:** Connections and takeoffs shall be made using 90 degree conical taps, 45 degree lateral taps or wye fittings constructed in accordance with SDCS Fig. 3-4 and 3-5. Use of 90 degree tees shall not be allowed.

3. **Spin-in Fittings:** Spin-in fittings may be used for duct taps to air supply and exhaust devices and shall include quadrant dampers even though a volume damper may be specified for the air device. Spin-in fittings shall be sealed at the duct tap with a gasket and compression fit or sealed with duct sealant. The location of spin-in fittings in the ducts shall be determined after terminal units are hung and the location of the light fixtures is known so as to minimize flexible duct lengths and sharp bends. Spin-ins shall be installed with their damper axis parallel to airflow.

4. **Flexible Joints In Ductwork:** Provide flexible connections where ductwork connects to air-handling units, fans, and similar powered equipment items and where required for expansion and contraction of the ductwork or the building structure. A minimum of one inch (1") slack shall be provided in all flexible connection to insure vibration isolation. Flexible joints are not required where equipment is connected with flexible duct. Flexible connections shall be rigidly connected to metal work on each side and shall be airtight. Bond flanges of flexible duct connectors to ducts and housings to provide airtight connections. Seal seams and penetrations to prevent air leakage.

D. **Elbows and Tees:**

1. **Rectangular Ductwork:** Provide radius or square elbows in ductwork, where shown on the Drawings. Where radius elbows are shown, radius elbows must be provided. Where square elbows are shown, square or radius elbows may be provided, at the Contractor's option. Elbows shall be constructed in accordance with SDCS Fig. 2-2. Turning vanes are required in all square elbows of 46 degrees or greater angle. Turning vanes are not required in radius elbows. Turning vanes shall be single vane type without a trailing edge and shall be constructed and installed in accordance with SDCS Fig. 2-3 and 2-4.

2. **Round Ductwork:** Provide radius elbows of the stamped or segmented type constructed in accordance with SDCS Fig. 3-3. Segmented elbows shall have a minimum of three segments for 45 degree elbows and five segments for 90 degree elbows.

E. **Offsets and Transitions:** Where duct width increases, maximum angle of slope shall be 20 degrees (one inch (1") in 2.7"). Where duct width decreases, maximum angle of slope shall be 30 degrees (one inch (1") in 1.7"). Offsets and transitions shall be constructed in accordance with SDCS Fig. 2-9 (type 2 and 3 only) and 2-10 (exclude C and E).

F. **Air Device Connections:** Make connections to air devices and fabricate air device plenums as detailed on the Drawings and in accordance with SDCS Fig. 2-16 through 2-18.

3.4 **DUCTLINER:**

A. **General:** The liner shall be applied to the inside of the duct with heavy density side to the air stream and shall be secured in the duct with adhesive, completely coating the clean sheet metal. All joints in the insulation shall be "buttered" and firmly butted tightly to the adjoining liner using fireproof adhesive. Where a cut is made for duct taps, etc., the raw edge shall be accurately and evenly cut and shall be thoroughly coated with fireproof adhesive. On ducts over 24" in width or depth, the liner shall be further
secured with mechanical fasteners. The fasteners shall be A.J. Gerrard Company pronged straps, or approved equal, secured to the ducts by fireproof adhesive. The clips shall be 18’’ maximum spacing and shall be pointed up with fireproof adhesive. Liner shall be accurately cut and ends thoroughly coated with fireproof adhesive so that when the duct section is installed, the liner shall make a firmly butted and tightly sealed joint. Ductliner for velocities over 2500 fpm shall be as specified except a perforated metal liner shall be used over ductliner for securement, in lieu of fasteners. Ductliner installation and fasteners shall comply with SDCS Fig. 2-22 through 2-25.

3.5 DUCTWORK INSTALLATION:

A. **General**: Assemble and install ductwork in accordance with recognized industry practices which will achieve airtight and noiseless systems, capable of performing each indicated service. Install each run with a minimum of joints. Align ductwork accurately at connections, within 1/8’’ misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers, and anchors of the type which will hold ducts true-to-shape and prevent buckling.

B. **Inserts**: Install concrete inserts for support of ductwork in coordination with formwork, as required to avoid delays in the work.

C. **Completion**: Complete fabrication of work at the project as necessary to match shop-fabricated work and accommodate installation requirements.

D. **Run Location**: Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, grams, details, and notations or, if not otherwise indicated, run ductwork in the shortest route which does not obstruct usable space or block access for servicing the building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent-enclosure elements of the building. Limit clearance to 0.5’’ where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork to assure 1.0’’ clearance of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate the layout with suspended ceiling and lighting layouts and similar finished work.

E. **Coordination**: Coordinate duct installation with installation of accessories, dampers, coil frames, equipment, controls, and other associated work of the ductwork system.

F. **Hangers and Supports**:

1. **General**: All ductwork supports shall be per Section IV of the SMACNA "HVAC Duct Construction Standards - First Edition" with all supports directly anchored to the building structure. Supports shall be on maximum 8’-0” centers with additional supports as required to prevent sagging.

2. **Attachment to Structure**: Provide hanger attachment to the building structure as specified in Section 23 03 00, "Basic Materials and Methods", and in accordance with SDCS Fig. 4-1 through 4-3.

3. **Hangers**: Hangers shall be strap or rod sized in accordance with SDCS Table 4-1 and 4-2. Strap hanger attachment to rectangular duct shall consist of a turning strap under the duct a minimum of one inch (1’’) and securing the strap with one screw into the bottom of the duct and one screw to the side of the duct. Rectangular duct supported on trapeze hangers shall be attached to the trapeze. Round duct attachments shall be constructed in accordance with SDCS Fig. 4-4.
4. **Horizontal Ducts:** Ducts larger than 50" in their greatest dimension shall be supported by means of hanger rods bolted to angle iron or half round trapeze hangers. Duct shall have at least one pair of supports 8'-0" on centers according to the following:

<table>
<thead>
<tr>
<th>Length</th>
<th>Angle</th>
<th>Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>4'-0&quot;</td>
<td>1-1/2&quot; x 1-1/2&quot; x 1/8&quot;</td>
<td>1/4&quot;</td>
</tr>
<tr>
<td>6'-0&quot;</td>
<td>1-1/2&quot; x 1-1/2&quot; x 1/8&quot;</td>
<td>1/4&quot;</td>
</tr>
<tr>
<td>8'-0&quot;</td>
<td>2&quot; x 2&quot; x 1/8&quot;</td>
<td>5/16&quot;</td>
</tr>
<tr>
<td>10'-0&quot;</td>
<td>3&quot; x 3&quot; x 1/8&quot;</td>
<td>3/8&quot;</td>
</tr>
</tbody>
</table>

5. **Vertical Ducts:** Ducts shall be supported where they pass through the floor lines with 1-1/2" x 1-1/2" x 1/4" angles for ducts up to 60". Above 60", the angles must be increased in strength and sized on an individual basis considering space requirements.

G. **Flexible Ductwork:**

1. **General:** Flexible ductwork shall be provided as shown on Drawings. Flexible ducts shall be installed in a fully extended condition free of sags and kinks, using only the minimum length required to make the connection, subject to the maximum lengths hereinbelow. Bends in any length of flexible duct shall not exceed 45 degrees for HVAC terminal unit connections or 90 degrees for air device connections and shall not exceed that recommended by the flexible ductwork manufacturer. Unless otherwise shown on the Drawings, the length of any one run of flexible ductwork shall not exceed 1'-6" for HVAC terminal unit connections or 8'-0" for air device connections. Where longer runs are required, provide externally insulated rigid duct extensions.

2. **Supports:** Where flexible duct extension exceeds 36", horizontally, a support shall be provided. Duct shall be suspended on 36" centers with a minimum 3/4" wide flat banding material and a minimum 6" wide sheet metal protective saddle. Refer to SDCS Fig. 3-9 and 3-10 and Page 3-17 for additional requirements.

3. **Terminal Unit Flexible Duct Connections:** All flexible duct connections upstream of HVAC terminal units shall be made by turning back the insulation and securing the inner liner with duct sealer and 1/2" wide positive locking stainless steel straps. The insulation shall then be placed over the joint and sealed on the exterior with self-locking nylon straps and an approved metalized duct tape. Refer to SDCS Page 3-13 and 3-15 for additional requirements.

4. **Air Device Flexible Duct Connections:** All air device flexible duct connections shall be made by turning back the insulation and securing the inner liner with 1/2" wide positive locking stainless steel straps or self-locking nylon straps and sealing with an approved metalized duct tape. The insulation shall then be placed over the joint and sealed on the exterior with an approved metalized duct tape. Spin-ins for air device taps shall be installed with their damper axis parallel to air flow. Refer to SDCS Page 3-13 and 3-15 for additional requirements.

H. **Duct Mounted Devices:**

1. Install duct mounted sensors and control devices furnished under [Section 23 06 00, “Building Controls”] [Division 23]. Provide access doors at each duct mounted control device. Coordinate location of devices and installation requirements with the [Section 23 06 00] [Division 23] Contractor.

2. Install duct type smoke detectors furnished under Division 26. Provide access doors at each sampling tube assembly. Coordinate location of detectors and installation requirements with Division 26.
3. Provide duct test ports in ductwork at locations shown on the drawings and as required to properly balance all air systems. Test ports shall be located per ANSI/ASHRAE Standard III to allow accurate pitot-tube traverse measurements in ductwork.

3.6 CLEANING AND PROTECTION:
A. **General:** Clean ductwork internally, section-by-section of dust and debris as it is installed. Clean external surfaces of foreign substances which might cause corrosive deterioration of the metal or, where ductwork is to be painted, might interfere with painting or cause paint damage.

B. **Repairs:** Strip protective paper from stainless ductwork surfaces and repair finish or replace ductwork portion wherever it has been damaged.

C. **Temporary Closure:** At ends of ducts which are not connected to equipment or air distribution devices at the time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent the entrance of dust and debris until such time that connections are to be completed.

3.7 TESTING:
A. **General:** Provide duct integrity and leakage testing for all supply and exhaust ductwork installed on the project. Testing shall be in accordance with the SMACNA HVAC Air Duct Leakage Test Manual, First Edition, 1985 (DLTM) and shall include, but not be limited to:

1. **Test Complete Systems:** Duct systems shall be tested as complete systems (e.g. from air handling equipment to terminal units/air devices, from terminal units to air devices or from air devices to exhaust (return fans). Duct systems shall not be tested in partial sections, unless approved in writing by the Engineer.

2. **Preparation for Testing:** Duct system installation must be complete, including, but not limited to, fittings, spin-ins, taps, access doors, hangers, test ports/holes, dampers and other system components. Temporary caps shall be installed at the system inlet (supply air system), system outlet (exhaust/return air systems) and at all terminal unit/air device taps.

3. **Leakage Calculations:** Prior to testing a duct system, the permissible leakage rate in cfm shall be calculated based on the square feet of duct surface and the duct system leakage classification.

4. **Test Configuration:** The configuration for testing shall be similar to DLTM Fig. 3-1, using a variable volume blower as a test air source, an orifice plate meter with an inclined manometer to measure leakage cfm and a manometer to measure duct static pressure.

5. **Acceptable Results:** Duct systems shall be tested, resealed and retested until acceptable results are obtained, eg. the measured leakage rate is equal to or less than the calculated permissible leakage rate.

6. **Documentation:** Duct system leakage testing results shall be recorded on forms which include the following information as a minimum:
   a. Duct System Tested.
   b. System Leakage Classification.
   c. Duct System Square Footage.
   d. Permissible Leakage Rate in CFM.
   e. Duct Test Pressure.
   f. Orifice Size.
   g. Measured Pressure Differential.
h. Measured Leakage Rate in CFM.

i. Measured Duct Pressure.

j. Test Performed By.

k. Date/Time of Test.

l. Temperature and Weather Conditions of Test.

m. Engineer or Owners Representative Signoff.

7. Duct leakage test reporting forms shall be submitted to the Engineer for approval.

B. Leakage Classifications:

1. Constant Volume Supply Air Ductwork: Ductwork shall be tested at leakage Class 12 at +2" wg.

2. Outside Air Ductwork: Ductwork shall be tested at leakage Class 6 at +3" wg.

3. Return Air Ductwork: Ductwork shall be tested at leakage Class 12 at -1" wg.

4. General Exhaust Ductwork: Ductwork shall be tested at leakage Class 12 at -2" wg.

END OF SECTION 23 31 13
SECTION 233114

DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, Supplementary General Conditions, all applicable requirements of Division 1, "General Requirements", and Section 230000, "Basic Mechanical Requirements", govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide ductwork accessories as shown on the Drawings, specified and required.

B. Types: The types of ductwork accessories required for the project include, but are not limited to:

1. Flexible connections.
2. Direction and volume control dampers.
3. Fire dampers.
4. Fire/smoke dampers.
5. Smoke Dampers.
6. Radiation dampers.
7. Flashing and counterflashing.
8. Turning vanes.
9. Duct access doors and inspection plates.
10. Test openings.
11. Screens.
12. Miscellaneous ductwork materials.

1.3 QUALITY ASSURANCE:


B. ASHRAE Standards: Comply with American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE) recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.

C. Certification: Fire, fire/smoke and smoke dampers shall be UL-listed, FM-approved and comply with applicable building code requirements.

D. Manufacturers: Provide products complying with the specifications and produced by one of the following:

1. American Foundry.
2. Duro-Dyne.
3. Elgin Sheet Metal Products.
5. Prefco.
6. Ruskin.
7. Tuttle and Bailey.
8. United Sheet Metal.
10. Ventlok.
11. Young Regulator Co.

1.4 SUBMITTALS:

A. Shop drawings submittals shall include, but not be limited to, the following:

1. Cut sheets of ductwork accessories, clearly indicating materials, construction dimensions, ratings, approvals, and other pertinent information.
2. Manufacturers' UL-approved installation instructions for fire, fire/smoke, and smoke dampers.
3. Additional information as required in Section 23 01 00.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver ductwork accessories in factory-fabricated water-resistant wrapping.
B. Handle ductwork accessories carefully to avoid damage to material component, enclosure and finish.
C. Store ductwork accessories in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 DUCTWORK ACCESSORIES, MATERIALS, AND FABRICATION:

A. General: Provide ductwork accessories which comply with Sections 23 01 00, "Ductwork", and 23 31 14, "Ductwork Accessories", for applicable product requirements of ductwork materials and as required for a complete ductwork system installation.

2.2 FLEXIBLE CONNECTIONS:

A. General: Flexible connections shall be minimum 3" wide and be UL-labeled, 30 ounces glass fabric-lined with insulation and coated on both sides with neoprene, complete with attachment accessories, "Vent-Glass" by Vent-Fabrics, Inc., Elgen "Zipper-lock" HZ-LN-14, Duro-Dyne Excelon "Metal-Fab", flexible connections shall be fabricated in accordance with Fig. No. 2-19 of the SMACNA HVAC Duct Construction Standards, 1985 Edition, or approved equal.

2.3 DIRECTION AND VOLUME CONTROL DAMPERS:

A. General: Provide all direction and balancing (volume control) shown or noted on Drawings. All damper control devices shall be installed so as to be fully concealed in finished rooms and spaces.
2. **Balancing Dampers:** Balancing dampers shall be provided in all zones of multi-zone air handling units, in all air device taps and where shown on the drawings. Refer to Section 23 01 00 “Ductwork” for air device flexible duct taps. Balancing dampers shall consist of single blade dampers in rigid round duct and rectangular duct up to 10” high and 12” wide, and opposed blade dampers in ducts 11” high and larger. Single blade dampers shall be in accordance with Fig. 2-14 of the SMACNA HVAC Duct Construction Standards (SDCS), 1985 Edition, and opposed blade dampers shall be in accordance with SDCS Fig. No. 2-15. Single blade dampers for rectangular duct shall be Ruskin MD35 22 ga. single blade galvanized steel dampers or an approved equal. Opposed blade dampers for rectangular duct shall be Ruskin MD35/OB 16 ga. Galvanized steel opposed blade dampers or an approved equal. Opposed blade dampers shall be provided with full length 1/2” square shafts, concealed linkage, nylon bearings, insulation build out and heavy duty locking hand quadrants. Air pressure drop through each balancing damper not to exceed 0.05” wg at design airflow. All balancing dampers shall have 100% free area with damper open.

3. **Damper Regulators:** Damper regulators for concealed accessible applications shall be Young Valcalox 400 series lever handle damper quadrants or an approved equal. Where regulators are installed on externally insulated ductwork, provide stand-off platforms at least 1/4” higher than the insulation thickness. Where damper regulators are required in non-accessible locations, provide access doors or Young or equal extension rods, couplings, 90 degree gear drives, etc. as required and Young 301 or approved equal flush mounted remote regulator as directed by the Architect.

4. **Extractors:** Provide extractors of the size and type indicated, with hex-key operated adjustable blades, with gang operated galvanized steel blades on one inch centers.

5. **Backdraft Dampers:** Provide all aluminum gravity type backdraft dampers with an extruded frame and roll formed blades with silicon impregnated felt seals. Blade height shall not exceed 4”, blade width shall not exceed 48” and blade linkage shall be provided to gang operate dampers by section.

C. **Operators:** Damper operators for concealed inaccessible ductwork shall be Young Regulator Company, Catalog No. 700 or No. 315, as shown. Non-insulated accessible ductwork shall be Young Regulator Company, Catalog No. 433. Accessible insulated ductwork shall be Young Regulator.
Company, Catalog No. 443. Approved equal units by Duro-Dyne or Vent Fabrics, Inc. will be acceptable.

2.4 FIRE DAMPERS:

A. General: Provide fire dampers at duct penetrations of rated floors, fire walls, elsewhere as shown in the Drawings. Fire dampers shall comply with the International Building Code Standard No. 43-7, be inspected and approved by an approved inspection agency and be labeled at the factory in accordance with Uniform Building Code Standard 43, Section 43.714. Dampers shall be UL-labeled and shall meet all of the requirements of NFPA 90A and UL Standard 555.

1. Provide 1 hour rated dampers where penetrations are in required 1 hour fire rated assemblies.

2. Provide 1-1/2 hour rated dampers where penetrations are in required 2 hour fire rated assemblies.

3. Provide 3 hour rated dampers where penetrations are in required 4 hour fire rated assemblies.

4. Dampers shall be activated by a UL-approved fusible link which shall automatically close the damper upon operation. Fusible links shall operate at approximately 50°F above the maximum temperature in the duct system in normal operation, but not less than 165°F. All dampers associated with Life Safety Systems shall have minimum 212°F fusible links. Hinged dampers shall have stainless or cadmium-plated spring steel catches. All dampers shall be dynamic rated and shall have spring closure to ensure positive shutoff at velocities up to 5000 fpm and pressures up to 10" wg.

5. Dampers shall be UL-rated per UL Standard 555 and shall be Ruskin Type DIBD Series, Style A, B or C, or an approved equal.

6. Dampers shall be sized so that the free area space is not less than 95% of the connected duct free area space for low velocity, low pressure ductwork and 100% of the connected duct free area space for high velocity, high pressure ductwork. Dampers shall be installed so as to provide a positive barrier to the passage of air when in the closed position. Dampers shall be installed with angle iron frames and slip joint connections per manufacturer's installation requirements and SMACNA Standards such that they are self-supporting in the case of duct destruction due to heat. The installing contractor shall be responsible for coordinating locations which require special sleeves.

7. Provide access doors as specified under ductwork for all internally actuated dampers. Where duct access doors are installed in non-accessible locations, provide ceiling or wall access doors. Label duct access doors "FIRE DAMPER ACCESS" with 1/2" high black stencil letters.

2.5 FIRE/SMOKE DAMPERS:

A. General: Provide low leakage fire/smoke dampers at all locations shown on the Drawings or required. Dampers shall be multi-blade type combination fire/smoke dampers and shall possess a 1-1/2 hour UL label in accordance with UL 555S and shall meet all requirements of the latest edition of NFPA 90A and 101. Dampers shall be tested and certified in accordance with AMCA Standard 500-75 and shall leakage Class II per UL Standard 555S.

1. Fire/smoke dampers and operators shall be UL-listed and labeled in the sizes used on the project and all dampers on the project shall be by the same manufacturer. UL-labeling of damper sizes used on the project shall be clearly indicated on shop drawing submittals.
2. Dampers shall be suitable for opening and closing at static pressure up to 6” wg and at air velocities up to 3500 fpm. Damper leakage shall not exceed 10 cfm/sf at one inch wg or 200 cfm/sf at 4” wg.

3. All combination fire/smoke dampers shall include an operating shaft which, when rotated, causes the damper to operate between open and closed. Operating shaft and damper combination shall be suitable for linking to and operation by any standard electric damper operator having sufficient torque characteristics. Combination fire/smoke dampers shall be Ruskin Type FSD-60 or an approved equal with 212°F thermal links and rectangular, round or oval duct connections as required.

4. Each combination fire/smoke damper shall be furnished complete with factory sleeve, damper operator, and thermal link factory-installed. The installing contractor shall be responsible for coordinating locations which require a special sleeve. Actuators shall be electric type as specified or required and shall be of the spring fail closed type that will close upon loss of power. Damper operators shall be UL-listed as fire damper operators, shall bear the appropriate UL fire damper operator label and shall be rated for continuous operation at 250°F.

5. A double pole double throw (DPDT) limit switch shall be provided factory-installed on each fire/smoke damper. The switch shall change position when the fire damper closes.

2.6 SMOKE DAMPERS:

A. **General:** Provide smoke dampers at all locations shown on the Drawings or required. Dampers shall meet all requirements for fire/smoke dampers except that the dampers shall not incorporate a thermal link feature.

2.7 RADIATION DAMPERS:

A. **General:** Ceiling radiation type fire dampers shall be installed in all UL design assembly fired rated ceilings in strict accordance with manufacturers UL-listed installation instructions. Ceiling dampers shall conform to UL Standard 555 and shall be Ruskin Model #CFD5A or approved equal rectangular or round neck damper with a fusible volume adjustment link for up to 20” diameter round or up to 18” x 18” square neck T-bar 24 x 24 face lay-in diffuser with 1/2” thick ceramic insulation blanket for diffuser pan. Air device pan shall be minimum of 24 gauge steel as required by UL. Thermal insulation blankets for radiation dampers shall be enclosed in an approved mesh material to allow easy handling of the blankets.

2.8 HIGH PRESSURE, LOW LEAKAGE, INDUSTRIAL CONTROL DAMPERS:

A. **General:** Provide factory-fabricated all stainless steel construction opposed blade-type control dampers as shown on the Drawings or required by the Sequence of Operation specified in section 23 06 00. Dampers shall be provided by the Division 23 contractor for control by the control subcontractor.

B. **Construction:** Dampers shall have stainless steel channel frames the full size of the duct or opening in which the damper is installed. Frames on dampers over 4 square feet shall have corner bracing. Damper frames shall be minimum 16 gauge formed stainless steel enclosed in a stainless steel round transition duct. Fabricate damper blades of not less than 16 gauge stainless steel with airfoil design. Damper blades shall have a maximum width of 6” and a maximum length of 48”. All dampers shall be provided with stainless steel bearings, stainless steel jamb seals, and stainless steel hardware as standard. Axles shall be a minimum of 1/2” diameter and be locked to the blade with rivets or be welded. All blades on each damper section shall be interconnected to act in unison. Maximum leakage rate through a 48” x 48” closed damper shall not exceed 32.0 cfm per square foot of damper face area at 10.0” of water pressure differential and a maximum closing torque of 50 inches/pounds. Damper
leakage ratings shall be certified in accordance with AMCA Standard 500. Dampers shall be Ruskin
CD30AF series low leakage control dampers or an approved equal and shall be rated for system
pressures up to 10.0" wg for damper blades up to 48" wide.

C. Damper Sizing: Two position dampers shall be full duct or louver size. Modulating dampers shall be
sized according to approach velocities, pressure drops, and similar criteria to obtain linearized
characteristics. Maximum approach velocity shall be 1500 feet/minute. Damper free area shall be
sized by the BCAS manufacturer. Provide necessary blankoff plates between damper leaves to obtain
the required free area. Damper sizing shall be submitted to the Engineer for approval.

D. Operating Temperature Range: Range shall be from -40°F to 180°F.

E. Operating Linkage: Linkage shall be factory-assembled and shall be capable of withstandng a load
equal to twice the maximum operating force of the damper operator without deflection.

2.9 AUTOMATIC MANIFOLD BLEED DAMPERS:

A. Provide heavy duty round butterfly or opposed blade control dampers as shown on the drawings and
required by the Sequence of Operation specified in section 23 06 00. The Division 23 contractor shall
provide dampers for control by the control subcontractor.

B. Dampers shall be 316 stainless steel construction. Dampers shall be butterfly type consisting of
round, mounted to axle within formed flanged frame. Frame shall be constructed of steel
channel and shall have full circumference blade stop located in air stream. Damper shaft shall be
continuous, solid cold rolled steel extending through entire diameter of damper and beyond damper
bearing a minimum of 6 inches. Axle shall be supported in sealed, relubricable ball bearings mounted
to damper frame. Damper frame and blade shall be fabricated from hot rolled steel. Damper frame
shall be minimum 10 gauge. Damper flanges shall be minimum 1 ½" wide. Provide bolt holes in both
flanges. Minimum blade thickness shall be ⅜". Axle diameter shall be minimum ¾". Dampers shall be
Ruskin model CDR92 or approved equal. At the contractor’s option these dampers may be rectangular
opposed blade dampers.

2.10 FLASHING AND COUNTERFLASHING:

A. General: Flashing and counterflashing shall be as specified in other Divisions of these Specifications.

2.11 TURNING VANES:

A. General: Provide turning vanes in the size and type indicated with the following additional construction
features:

1. **Blades:** 2" galvanized steel for up to and including 18" ducts.
2. **Blades:** 4-1/2" galvanized steel for ducts over 18".
3. **Construction:** Single wall blade, constructed in accordance with Fig. No. 2-3 and Fig. No. 2-4 of
4. **Types:** Fixed blades for 90 degree elbows, adjustable for transition elbows and fixed for
   45 degree elbows where shown.

2.12 DUCT ACCESS DOORS AND INSPECTION PLATES:

A. **Access Doors:** Provide Flexmaster Inspector Series Spin-In low leakage, round, high pressure, dual
   wall, insulated access doors in ductwork as required for access to fire, smoke and fire/smoke dampers,
   duct smoke detectors, sampling tubes, humidifiers and other duct mounted devices. Minimum door
size shall be 12" round unless a smaller size is required due to duct dimensions. Square access doors shall be constructed in accordance with Fig. No. 2-12 and 2-13 of the SMACNA HVAC Duct Construction Standards, 1985 Edition.

B. Inspection Plates: Provide inspection plates where shown on the Drawings. If not detailed, provide a minimum opening of 4" x 4" with a 6" x 6" cover plate. The cover plate shall be one gauge heavier than the ductwork, gasketed and secured with a minimum of eight sheet metal screws.

2.13 TEST OPENINGS:

A. General: Ventlok No. 699 instrument test holes in locations as required to measure pressure drops across each item in the system, e.g., O.A. louver, filters, fans, coils, intermediate points in duct runs, etc. Test holes in stainless steel duct systems shall be 316 stainless steel or an approved corrosion resistant design.

2.14 SCREENS:

A. General: Provide screens on all duct, fan, etc., openings furnished by this Contractor which lead to, or are, outdoors. Screens shall be No. 16 gauge, 1/2" galvanized steel mesh in removable galvanized steel frame. Provide safety screens meeting OSHA requirements for protection of maintenance personnel on all fan inlets and fan outlets to which no ductwork is connected.

2.15 MISCELLANEOUS DUCTWORK MATERIALS:

A. General: Provide miscellaneous materials for ductwork accessories, including hinges, refrigerator latches, sash locks, bolts and wing nuts, gaskets and pitot tubes as recommended by the ductwork accessories manufacturer for the application indicated.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Flexible Connections: Install flexible connections where ducts connect to fans, including roof exhausters. There shall be a minimum of 1/2" slack in the connections, and a minimum of 2-1/2" distance between the edges of the ducts except that there shall also be a minimum of one inch (1") of slack for each inch of static pressure on the fan system.

B. Dampers: Install balancing, splitter and backdraft dampers where shown on the Drawings and wherever necessary for complete control of the airflow, including all supply, return and exhaust branches, "division" in main supply, return and general exhaust ducts, each individual air supply outlet and fresh air ducts. Where access to dampers through a fixed suspended ceiling is necessary, this Contractor shall be responsible for the proper location of the access doors. Install balancing dampers in each zone of multi-zone units.

C. Fire, Fire/Smoke and Smoke Dampers: Install fire, fire/smoke and smoke dampers as detailed on the Drawings and in strict accordance with the damper manufacturers UL-approved installation instructions.

D. Flashing: Install flashing where ducts pass through roofs or exterior walls, suitable flashing shall be provided to prevent rain or air currents from entering the building. The flashing shall be of not less than No. 24 gauge 316 stainless steel.

E. Turning Vanes: Install turning vanes per SMACNA standards. Turning vanes in ducts carrying air under pressure of 1-1/2" water gauge or more shall be anchored to the cheeks of the elbow in such a way that the cheeks will not breathe at the surfaces where the vanes touch the cheeks. In most cases,
this will necessitate the installation of an angle iron support on the outside of the cheek parallel to the line of the turning vanes.

F. **Access Doors**: Install access doors so that the doors open against the system air pressure wherever feasible and that their latches are operable from either side, except where the duct is too small to be entered. Provide access to each fire damper link to permit resetting. Comply with City Code Requirements and NFPA 96. Install hinged access doors in ductwork to provide access to all fire dampers, mixed air plenums, upstream of steam reheat coils, automatic dampers, etc. Where the ducts are insulated, the access doors shall be double skin doors with one inch of insulation in the door. Where access doors are located above a suspended ceiling, this Contractor shall be responsible for the proper location of the ceiling access doors, if the ceiling system does not provide proper access.

G. **Inspection Plates**: Install plates at each multi-zone zone damper and where otherwise indicated on the Plans.

H. **Test Openings**: Install test openings for pitot transverse of all supply, return, and exhaust duct connections to fan powered equipment, at each duct mounted balancing damper and at other locations required for proper measurement of airflow in all duct systems.

3.2 **TESTING**:

A. **General**: Check installed ductwork accessories for required operation and leakproof performance during the system's operational test. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.

B. **Damper Testing**: Test all fire, fire/smoke and smoke dampers for proper operation after the damper installation is complete. Dampers which exhibit any binding or other forms of impaired operation shall be replaced and retested. Refer to Section 23 05 93 for additional requirements.

C. **Damper Certification**: The Contractor shall include in the Operating and Maintenance Manuals, a letter certifying that all fire, fire/smoke and smoke dampers have been tested and are fully operational. Refer to Section 23 05 93 for additional requirements.

**END OF SECTION 23 31 14**
SECTION 233713
AIR DISTRIBUTION DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, Supplementary General Conditions, all applicable requirements of Division 1, "General Requirements", and Section 230000, "Basic Mechanical Requirements", govern this Section.

1.2 DESCRIPTION OF WORK:
A. Work Included: Provide air distribution devices and accessories as specified, scheduled, and shown on the Drawings.
B. Types: The types of air distribution devices required for the project include, but are not limited to:
   1. Ceiling diffusers.
   2. Registers and grilles.
   3. Light troffer boots.
   4. Linear slot diffusers.
   5. Perimeter supply/return slot diffusers.

1.3 QUALITY ASSURANCE:
A. Manufacturers: Devices manufactured by Metal-Aire, Titus, Krueger, Anemostat/Waterloo, Aeronca, Carnes, or Barber-Coleman will be acceptable if the devices furnished comply with these Specifications, the conditions scheduled and are similar in appearance and performance to the units scheduled.
B. NFPA Compliance: Comply with National Fire Protection Association (NFPA) Standard NFPA 90, as applicable to air diffuser construction and installation.
C. Design Compliance: When directed by the Engineer, test air outlets to verify compliance with these Specifications. Perform all revisions required to comply with terminal velocity, noise level or maximum temperature variation requirements at no cost to the Owner or Engineer.
D. Air Distribution Equipment: Maximum space temperature variation shall not exceed 2°F through the conditioned area from 2' above the floor, to 7' above the floor. The air outlets shall be selected by the manufacturer to suit the volume, throw and noise level scheduled as shown on the Drawings and maintain maximum terminal velocities of 50 fpm, unless otherwise indicated.

1.4 SUBMITTALS:
A. Shop Drawing submittals shall include, but not be limited to, the following:
   1. Submit cutsheets on air devices clearly indicating all features, accessories, mounting provisions, throw, pressure drop, noise criteria, and other pertinent performance data clearly indicated.
   2. Submit dimensioned drawings for all custom and special dimension linear slot diffusers and air devices.
3. Submit test data and results as specified herein. Test results shall be certified by an authorized officer of the company.

4. Additional information as required in Section 23 01 00.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver air distribution devices in factory-fabricated water-resistant wrapping.

B. Handle air distribution devices carefully to avoid damage to material component, enclosure, and finish.

C. Store air distribution devices in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 AIR DISTRIBUTION DEVICE GENERAL REQUIREMENTS:

A. General: Provide air distribution devices of the size, shape, and type, constructed of materials and components and with finishes as scheduled and shown on the Drawings. Grilles, registers and ceiling outlets shall be provided with sponge rubber or soft felt gaskets. If a manufacturer other than the one scheduled is used, the sizes shown on the Drawings shall be checked for performance, noise level, face velocity, throw, pressure drop, etc., before the submittal is made. Selections shall meet the manufacturer's own published data for the above performance criteria. The throw shall be such that the velocity at the end of the throw in the five foot occupancy zone will be not more than 50 fpm nor less than 25 fpm. Noise levels shall not exceed those published in the ASHRAE Guide for the type of space being served (NC level).

B. Compatibility: Air distribution devices shall be fully compatible with the surfaces in which they are installed and shall be provided with all required mounting accessories for installation in the actual construction at the installation location.

C. Finishes: All ceiling and wall mounted air devices shall be painted white or off white unless specified otherwise and all air devices shall be the same color. Where the factory finish on all devices is not the same as determined by the Architect/Engineer, then the Division 23 Contractor shall be responsible for coordinating field painting of air devices by the Division 9 Contractor. The Division 23 Contractor shall be responsible for all costs associated with painting of white or off white air devices. Special color painting of air devices shall be the responsibility of the Division 9 Contractor. The Architect/Engineer's decision on white color compatibility is final.

D. Ceiling Diffusers: Provide diffusers with corrosion resistant treated surfaces and finished in off-white baked enamel unless otherwise specified, scheduled, or shown on the Drawings. Provide opposed volume control dampers with supply air diffusers where scheduled. Where applicable, provide adapters with diffusers to permit connection to round supply duct. The interior of all perforated plate diffusers shall be painted flat black. Perforated plate supply air diffusers shall have pattern control blades installed in the diffuser neck. Pattern controllers attached to the perforated plate are not acceptable. Provide concealed fastening on all ceiling diffusers.

E. Registers and Grilles: Provide registers which contain a key-operated multi-louvered opposed blade damper operable from the face side, unless scheduled otherwise. Supply air registers shall be of the double deflection type, unless scheduled. Return air grilles and registers shall have fixed face blades and match the face of the supply air registers, unless scheduled otherwise. Provide concealed fastening for all registers and grilles.
F. High Induction Perimeter Supply/Return Slot Diffuser:

1. Provide slot-type supply/return (where scheduled) diffuser with length and width scheduled or shown on the Drawings. The supply/return diffuser shall be installed above the ceiling and located as indicated on the Architectural and Mechanical Drawings. The perimeter supply linear boot diffusers shall have an internal, fixed, curved, aerodynamically shaped outlet designed to provide the maximum amount of induced secondary room air. The return air slot (where scheduled) shall be located so that the supply air pattern will not be affected. The supply air shall be discharged horizontally along the ceiling with a down discharge center section (where scheduled).

2. The diffuser shall be designed, tested, and constructed in a manner so as to comply with the performance criteria and sound level requirements specified hereinafter. Diffuser shall be constructed of at least 24 gauge galvanized steel and shall be reinforced as required. The air volume, length and duct connection size shall be as scheduled or shown on the Drawings. The diffuser manufacturer shall coordinate the attachment, support, tee spacing, and similar features of the diffuser with the ceiling Subcontractor.

3. The entire assembly shall be tested as a unit at the manufacturer's laboratory. Submit certified copies of the test results to the Engineer for review. The test data shall include AK factors for an Alnor velometer, sound data, diffuser static pressure drop, horizontal air throw, and drop for the air supply rates per lineal foot of diffusers indicated below. The test data shall be based on a 55°F air supply temperature, a 20°F temperature differential and an 85°F heating supply air temperature.

4. The diffuser shall be painted flat black on interior surfaces and the exposed surfaces as viewed from below the ceiling system shall be painted flat black. The entire diffuser assembly shall be externally insulated with ductwrap insulation with a continuous vapor barrier.

5. The perimeter ceiling supply/return linear boot diffuser shall be similar to the Titus Model scheduled and detailed on the Drawings and shall be designed to equal or exceed the following performance characteristics:

<table>
<thead>
<tr>
<th>CFM/ LIN. FT.</th>
<th>MAX. DIFFUSER THROW @ 50 FPM TERMINAL</th>
<th>STATIC PRESSURE LOSS - IN W.C.</th>
<th>VELOCITY NC LEVEL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Titus Nova Model - N1/N1D (R with Return Slot)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>0.1</td>
<td>7'</td>
<td>Less than 20</td>
</tr>
<tr>
<td>40</td>
<td>0.1</td>
<td>14'</td>
<td>Less than 23</td>
</tr>
<tr>
<td>50</td>
<td>0.1</td>
<td>17'</td>
<td>Less than 30</td>
</tr>
<tr>
<td>60</td>
<td>0.15</td>
<td>19'</td>
<td>Less than 34</td>
</tr>
<tr>
<td>70</td>
<td>0.20</td>
<td>21'</td>
<td>Less than 38</td>
</tr>
<tr>
<td>Titus Nova Model - N4/N4D (R with Return Slot)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>0.010</td>
<td>16'</td>
<td>Less than 20</td>
</tr>
<tr>
<td>40</td>
<td>0.15</td>
<td>19'</td>
<td>Less than 26</td>
</tr>
<tr>
<td>50</td>
<td>0.20</td>
<td>22'</td>
<td>Less than 33</td>
</tr>
</tbody>
</table>

* Based on 10 dB room absorption.

6. The Engineer will have the option to witness additional tests after receipt of certified test results to verify compliance with these Specifications.
2.2 AIR DISTRIBUTION DEVICES:

A. **Linear Slot Type Air Devices**: Devices shall be high induction, side inlet slot diffusers with length and neck size as scheduled or shown on the Drawings. The diffusers shall have an aerodynamically designed, venturi-shaped air outlet designed to direct supply air horizontally across the ceiling and to provide maximum aspiration and entrainment of room air. The supply air shall maintain a ceiling pattern with varying volumes of air to minimum flow. The diffuser shall have a maximum height of 9" and shall be completely supported by two ceiling tee’s on nominal 2-3/4" centers. The diffuser shall be constructed of minimum 24 gauge nonrusting steel and all surfaces exposed to view below the ceiling shall be painted flat black. [Diffusers shall be factory-insulated with external ductwrap insulation with a continuous vapor barrier.] Titus Nova [N-1-8] [N-1-9] [N-4-8] Series.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. **General**: Install air distribution devices in accordance with manufacturer's written instructions and recognized industry practices to ensure that products serve intended functions.

B. **Coordination**: Coordinate with other trades, including ductwork, and ductwork accessories, as necessary to interface air distribution devices properly with other work.

C. **Locations**: Locations of air distribution devices shown on Drawings are approximate and shall be coordinated with other trades to make symmetrical patterns and shall be governed by the established pattern of the lighting fixtures. Where air distribution devices are installed in acoustical tile and other ceilings they shall be either centered on tile or ceiling joints as directed by Architect at job site. Coordinate location of all ceiling air devices with Architectural reflected ceiling plans. All devices installed in UL floor/ceiling or roof/ceiling assemblies shall be compatible with the assembly specified on the Architectural Drawings.

D. **Mounting Provisions**: Coordinate mounting provisions and accessories required for proper installation of air devices in finish and construction at the point of installation. Refer to details on the Mechanical and Architectural Drawings for special installation details and provide all mounting accessories shown or required for the complete and proper installation of each air device.

E. **Accessories**: Where scheduled, the grilles, registers and ceiling outlets shall be provided with deflecting devices and manual balancing damper. These devices shall be the standard product of the manufacturer, subject to review by the Architect, and equal to brand scheduled.

F. **Insulation**: Refer to Section 23 07 00, "System Insulation", for field insulation of air devices, where required.

G. **Security Air Devices**: Tamper resistant air devices in Secure Areas shall be installed in accordance with Manufacturer's recommendations for the construction types used on the project. In all cases, tamper resistant air devices shall be securely mounted to the building construction.

3.2 BALANCING ACCESSORIES:

A. **General**: Provide factory-calibrated balancing cones for use in air balancing all types of ceiling outlets, linear diffusers or any other special outlet. All cones shall be calibrated for use with Alnor velometer and identified with airflow factors permanently indicated on the sides of the cones.

3.3 FIELD QUALITY CONTROL:

A. **Test**: Test installed devices to demonstrate satisfactory compliance with specified and indicated requirements.
B. **Adjustment:** Adjust air distribution devices to provide air distribution patterns shown on the drawings or required.

C. **Air Balancing:** Balance the airflow through each air device to the volumes shown on the Drawings. Refer to Section 23 05 93 for additional balancing requirements.

**END OF SECTION 23 37 13**
PART 1 - GENERAL

1.1 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, Supplementary General Conditions, all applicable requirements of Division 1, "General Requirements", and Section 230000, "Basic Mechanical Requirements", govern this Section.

1.2 DESCRIPTION OF WORK:
A. Work Included: Provide filters and accessories as specified, scheduled, and shown on the Drawings.
B. Types: The types of filters required for the project include, but are not limited to:
   1. Unit mounted pleated filters.

1.3 QUALITY ASSURANCE:
A. Manufacturers: Provide filters and accessories complying with these specifications and produced by the following:
   1. American Air Filter.
   2. Cam-Farr.

1.4 SUBMITTALS:
A. Shop drawing submittals shall include, but are not limited to, the following:
   1. Cut sheets on all filter types required for the project, clearly indicating type, construction, materials, sizes, ratings, classification, and other pertinent filter information.
   2. A listing of all filter types and sizes to be provided for the project.
   3. Cut sheet on all filter housings and assemblies clearly indicating sizes, construction, connection types, ratings, features controls, and other pertinent information.
   4. Certification that filters and filter housings and assemblies have been coordinated with served equipment and with filter racks/banks furnished by air handling equipment manufacturers.
   5. Additional information as required in Section 23 01 00.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:
A. Deliver filters and accessories in factory-fabricated water resistant packaging.
B. Handle filters and accessories carefully to avoid damage to material components and enclosures.
C. Store filters in a clean, dry space and protect from the weather.
2.1 PLEATED FILTERS:
   A. General: Provide high efficiency, pleated, disposable type filters where scheduled or shown on the Drawings.
   B. UL-listing: Filters shall be listed by Underwriters' Laboratories, Inc. as Class [1] [2].
   C. Filter Media: Filter media shall be of the nonwoven cotton fabric type. The filter media shall have an average efficiency of at least 40% in accordance with ASHRAE Test Standard 52-76.
   D. Capacity: Ratings and capacity for pleated filters shall be as follows:
      a. Two Inch: The effective filter media shall be not less than 4.6 square feet of media per 1.0 square foot of filter face area and shall contain not less than 15 pleats per linear foot. Initial resistance of 500 fpm approach velocity shall not exceed 0.28" w.g.
      b. One Inch: The effective filter media shall be not less than 2.3 square feet of media per 1.0 square foot of filter face area and shall contain not less than 16 pleats per linear foot. Initial resistance at 500 fpm approach velocity shall not exceed 0.45" w.g.
   E. Media Support Grid: The filter media support shall be a welded wire grid with an effective open area of not less than 96%. The welded wire grid shall be bonded to the filter media to eliminate the possibility of media oscillation and media pull away. The media support grid shall be formed in such a manner that it effects a radial pleat design, allowing total use of filter media.
   F. Enclosing Frame: The filter enclosing frame shall be constructed of a rigid, heavy-duty, high wet-strength beverage board, with diagonal support members bonded to the air entering and air exit side of each pleats, to ensure pleat stability. The inside periphery of the enclosing frame shall be bonded to the filter pack, eliminating the possibility of air bypass.
   G. Manufacturers: Filters shall be MERV 8 High Efficiency rated, American Air Filter PerfectPleat, Farr 30-30 or an approved equal.

2.2 PLEATED FILTER RACKS:
   A. General: Pleated filters shall be installed in V-bank or flat filter racks as required to provide maximum filter velocity as scheduled or shown on the Drawings. Racks shall be provided with air handling units and are specified in Section 23 62 13, "Air Cooled Split System Air Conditioning Units".
   B. Filter Racks: Provide American Air Filter, Farr or equal galvanized steel flat filter racks suitable for mounting on the air handling equipment which it serves. Racks shall be equipped with gaskets and spring type positive sealing fasteners to hold filters in place. Fasteners shall be removable without the use of tools.

PART 3 - EXECUTION

3.1 INSTALLATION:
   A. General: Install filter racks, housings, and filters in accordance with the manufacturers' written installation instruction.
   B. Coordination: This contractor shall coordinate equipment and filter bank connection requirements and provide transitions as required for proper installation of filters.
3.2 AIR FILTERS:

A. **General**: Install all filters protecting equipment prior to unit startup. Under no circumstances shall any air handling unit or fan and coil unit which is shown or specified to be furnished with filters be operated without filters in-place. Filters on units used during construction shall be replaced as necessary and as directed by General Contractor.

B. **Coil Cleaning**: In the event that units are operated without filters in-place or with filters which have been damaged so as to allow air to bypass filter, the Contractor shall steam clean all coils and fans in that particular system before balancing the system.

C. **Filter Sizes**: In all cases, filters shall be of the proper size and installed in filter racks in such a manner that there will be no leakage of air around filters. Filters which have been torn, distorted, or damaged in any other way will not be acceptable.

D. **Temporary Prefilters**: Provide blanket insulation or roll filter media over pleated filters as temporary prefilter during construction.

E. **Testing and Balancing**: All testing and balancing of air-side systems shall be done using clean filters. Where required, filters which have been used, shall be replaced prior to testing and balancing of air systems.

F. **Clean Filters**: Upon completion of the project and before final acceptance, all disposable media filters shall be replaced with new media.

G. **Spare Filters**: Furnish one complete stock of replacement filters and media, sufficient to replace all filters on the project, to the Owner for maintenance use. Filters shall be delivered in their original, unopened containers, and stored as directed by the Owner.

END OF SECTION 23 40 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, Supplementary General Conditions, all applicable requirements of Division 1, "General Requirements", and Section 230000, "Basic Mechanical Requirements", govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide split system air-conditioning unit work including, but not limited to, the furnishing and installation of:
   1. DX/Electric heat air handling units with related accessories and controls.
   2. Air-cooled DX condensing units with related accessories and controls.
   3. Manufacturer’s controls that provide a complete and operational system independent of any other building controls.

1.3 QUALITY ASSURANCE:

A. Manufacturer: Provide products of one of the following:
   1. Carrier Corporation,
   2. AAON
   3. RECO,
   4. Trane Company,
   5. York,
   6. McQuay
   7. Approved Equal.


C. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.

D. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.

E. Unit Seasonal Energy Efficiency Ratio (SEER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.

F. Unit shall be safety certified by ETL and ETL US listed. Unit nameplate shall include the ETL/ETL Canada label.
1.4 SUBMITTALS:

A. Shop drawings submittals shall include, but are not limited to, the following:
   1. Unit cutsheets clearly showing all features, accessories, dimensions, weights and capacities.
   2. Written instructions for equipment to installation.
   3. Wiring and piping diagrams and connection locations.
   4. Refrigerant piping sizing calculations.
   5. Performance certifications and test results.
   6. Warranty information.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver DX/Electric heat air handling units, condensing units and accessories in factory-fabricated water-resistant wrapping.

B. Handle DX/Electric heat air handling units, condensing units and accessories carefully to avoid damage to material components, enclosure and finish.

C. Store DX/Electric heat air handling units, condensing units and accessories in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 DX/ELECTRIC HEAT AIR HANDLING UNITS:

A. General: Provide the DX/Electric heat air handling units manufacturer's standard materials, components and accessories as indicated by product information, designed and constructed as recommended by the manufacturer and as required for a complete installation, except as otherwise indicated. Units shall be rated and tested in accordance with ARI 210, 240 and 360 and shall be UL listed and labeled in accordance with UL 465/1995.

B. Units: Air handling units shall be completely factory assembled in an insulated vertical housing, complete with DX cooling coils, condensate drain pan, fan, fan motor, electric heater (where scheduled), filters, controls and accessories. Units shall be factory wired for a single point electrical connection.
   1. Unit shall have a draw-through supply fan configuration and discharge air horizontally.
   2. Unit shall be factory assembled and tested including leak testing of the DX coil, and run testing of the supply fans and factory wired electrical system. Run test report shall be supplied with the unit.
   3. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
   4. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment’s hinged access door.

C. Casings: Casings shall be constructed of heavy gauge zinc-coated, galvanized steel. Exterior surfaces shall be cleaned, phosphatized and coated with an epoxy resin primer and finished with an enamel finish. Casing shall be completely insulated with fire-retardant, permanent, odorless glass fiber material.
1. Unit insulation shall have a minimum thermal resistance R-value of 6.25. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610°F.

2. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel and prevents exterior condensation on the panel.

3. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.

4. Access to filters shall be through hinged access door with quarter turn fasteners.

5. Access to cooling coil shall be through hinged access door with lockable quarter turn handles.

6. Access to dampers shall be through hinged access door with lockable quarter turn handles.

7. Access to external control panel shall be through hinged access door with tooled entry.

8. Access to supply fan shall be through an access door with removable pin hinges and lockable quarter turn handles.

9. Access doors shall be flush mounted to cabinetry.

10. Units with a cooling coil shall include sloped 304 stainless steel drain pan. Drain pan connection shall be on the right hand side of unit with a 1” MPT fitting.

11. Cooling coil shall be mechanically supported above the drain pan by multiple supports that allow drain pan cleaning and coil removal.

D. Refrigerant Circuits: Units up to 7-1/2 tons shall have a single refrigerant circuit. Units 10 tons and larger shall have dual refrigerant circuits. Each refrigerant circuit shall be controlled by a factory installed thermal expansion valve.

E. Evaporator Coils: Evaporator coils shall be configured aluminum fins mechanically bonded to seamless copper tubing for use with R-410A refrigerant. Coils shall be factory pressure and leak-tested to 375 psig air pressure. Coils shall be arranged for draw-thru airflow and shall be completely factory assembled, including expansion valves. Coils shall have condensate drain pans with external drain connections on each side of the unit. Dual circuited coils shall be circuited in an intertwined configuration. Coil shall be 6 row and 12 fins per inch. Coil shall be hydrogen or helium leak tested. Coil shall be furnished with factory installed thermostatic expansion valves. The sensing bulbs shall be field installed on the suction line immediately outside the cabinet. Coil shall have right hand external piping connections. Liquid and suction connections shall be sweat connection. Coil connections shall be labeled, extend beyond the unit casing, and be factory sealed on both the interior and exterior of the unit casing to minimize air leakage.

F. Cabinet Construction/Finish: Cabinet shall be constructed of galvanized steel with an acrylic high-heat baked-on enamel finish. The blower cabinet shall be internally insulated.

G. Fan Section: Provide fan section (blower unit) as scheduled.

1. Centrifugal Fans: Provide double width, double inlet, multiblade type fans with air foil, forward curved or backward inclined blades, as scheduled. All fans shall be statically and dynamically balanced and tested after being installed on properly sized shafts. Fan shafts must not pass through their first critical speed as unit comes up to rated rpm. Fan wheels and scrolls shall be constructed of galvanized steel, all aluminum or fabricated steel protected with two coats of rust-
inhibiting paint. Wheels and scrolls of fans used for outside air service shall be coated with two coats of fire resistant epoxy paint.

2. **Sheaves:** Permanent fan sheaves shall be nonadjustable with removable machined bushings, machined on all contact surfaces. Sheaves with over three grooves shall be dynamically balanced and so designated on each sheave. Fan sheaves with three grooves or less shall be statically balanced and if weights are required, they shall be welded to the sheave. Sheaves shall be manufactured by Browning, Eaton Yale and Towne, Dodge Manufacturing Company or Fort Worth Steel and Machinery Company.

   a. **Air Handling Units:** Provide a nonadjustable type sheave selected for the rated fan rpm as determined. Provide variable sheaves as required to determine correct fan rpm as established by tenant requirements. Furnish additional fixed sheaves as required after correct speed has been determined. All unused fixed sheaves shall become the property of the Owner.

3. **Belts:** Provide "V-groove" type suitable for the service intended with the capacities specified. Belts shall be closely matched and tagged for use prior to shipment. Recheck belts for proper match during operation and if necessary, replace with closely matched belt sets. Belts shall be Gates, Durkee-Aiwood, Goodyear, Uniroyal or Browning.

   a. **General:** Provide belt guards for all fan drives mounted outside the unit housing. The finish of the guard shall be similar to that of the unit housing. Brace and fasten guards to prevent objectionable vibration. Provide tachometer openings at least 2" in diameter for checking fan and motor speeds. Openings shall be centered on shafts to allow checking rpm.

4. **Shafts:** Provide one piece design shafts, either solid or hollow tube with solid stub. Hollow tube with solid stub shafts shall be hot-formed, stress relieved, and manufactured by Pittsburgh Tubular Shafting, Inc. Fans and shafts shall not pass through their first critical speed as the unit comes up to rated rpm.

5. **Shaft Bearings:** Provide externally or internally mounted grease lubricated, self-aligning ball or roller bearings on each end of the shaft. Bearings shall have an average B-10 life as defined by AFBMA of 100,000 hours at design operating conditions. All bearings shall be the same size. Internally mounted bearings shall have grease lines extended so as to be readily accessible from the drive side of the unit. In addition, the bearing on the drive end of the shaft shall have grease line extended beyond the belt guard. All grease lines shall terminate in a zerk fitting. Bearings shall be by SKF, Sealmaster, Timken, or Fafnir.

H. **Blower Motor/Drive:** Blower motors shall be energy efficient 3 phase open drip-proof type. Refer to Section 23 04 00 for additional requirements. Blower drive shall be a belt drive with adjustable pitch pulleys.

I. **Blower Motor Starter:** A factory wired, unit mounted NEMA type motor starter with 3 phase overloads and a control power transformer shall be provided.

J. **Filter Rack/Filters:** Provide units 3, 4, 5 with a filter rack and 1" disposable filters. Provide units 1 and 2 with 2 inch thick, pleated panel filters with an ASHRAE efficiency of 30% and MERV rating of 10, upstream of the cooling coil.

K. **Duct Connections:** Unit shall be designed for outside air, return air and supply air connections as shown on the drawings.

   1. Unit shall contain a mixing box with front return air opening and top outside air opening.

   2. Return air opening shall contain an adjustable, motor operated outside air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and end
seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Dampers shall be controlled by a fully modulating actuator.

3. Outside air opening shall contain an adjustable, motor operated outside air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Dampers shall be controlled by a fully modulating actuator.

L. Operating Controls: Furnish unit controls including system of automatic sequencing, safety and operating controls consisting of the following:

1. High temperature cutoff.
2. Differential air pressure switch to verify air flow.
3. 115/24 volt control transformer.
4. Programmable Space Thermostat for continuous fan operation during programmed occupied conditions.
5. Two-stage heater capacity control (where scheduled).
6. Firestat.
7. Interlock unit controls with fan or air unit so that unit may not be energized with fan not in operation.

M. Performance/Ratings: Provide minimum performance as scheduled on drawings.

N. Warranty: Manufacturer shall provide a limited “parts only” warranty for a period of 12 months from the date of equipment start up or 18 months from the date of original equipment shipment from the factory, whichever is less. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer’s written instructions for installation, operation, and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts and air filters.

2.2 AIR-COOLED DX CONDENSING UNITS:

A. General: Provide the DX condensing unit manufacturer’s standard materials, components and accessories as indicated by product information, designed and constructed as recommended by the manufacturer and as required for a complete installation, except as otherwise indicated. Units shall be UL 1995 listed and rated in accordance with ARI Standard 210/240, 360 and 270.

B. Units: Provide air cooled condensing units of the size, type, capacity and arrangement as shown and scheduled on the Drawings. Condensing units shall be assembled on a heavy-gauge integral steel mounting/lifting base. Units shall be weatherproofed and include hermetic compressor(s), condensing coils, fans and motors, controls and holding charge of refrigerant. Units shall have a control box access panel and removable end panels which allow access to all major components and controls.

C. Unit shall be factory assembled and tested including leak testing of the coil and run testing of the completed unit. Run test report shall be supplied with the unit in the control compartment.

D. Unit Frame: Frame shall be a welded assembly of heavy gauge zinc-coated, galvanized steel. Drainage holes shall be provided as required. Exterior surfaces shall be cleaned, phosphatized and
coated with an epoxy resin primer and finished with an enamel finish. Units shall have removable end panels for access to all major components and controls.

E. **Refrigeration Circuits:** Units up to 7-1/2 tons shall have single compressors and a single refrigerant circuit for use with a single circuit cooling coil. Units 10 tons and larger shall have two compressors and two independent refrigerant circuits for use with a dual circuit cooling coil. Each refrigeration circuit shall have an integral subcooling circuit and a refrigerant filter/dryer.

F. **Compressors:** Each compressor shall be a direct-drive hermetic type with centrifugal oil pump; two-point lubrication for each bearing and connecting rod; thermostatically controlled crankcase heater and well; high strength, ring-type suction and discharge valves; large gas passages and minimum clearance volumes; and internal spring isolation and muffling. External high and low cutout devices shall be provided. Evaporator defrost control provided in the indoor blower coil shall prevent compressor slugging by temporarily interrupting compressor operation when low evaporator coil temperatures are encountered.

G. **Units 1 and 2 shall have the following Refrigeration System:**

1. Unit shall be provided with independently circuited R-410A variable capacity scroll compressor with thermal overload protection. Variable capacity scroll compressors shall be utilized on the lead refrigeration circuit and shall be capable of modulation from 10-100% of its capacity.

2. Each compressor shall be furnished with a crankcase heater and carry a 1 year non-prorated warranty, from the date of original equipment shipment from the factory.

3. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged access doors shall provide access to the compressors.

4. Compressors shall be isolated from the base pan with the compressor manufacturer’s recommended rubber vibration isolators and mounted on an elevated compressor deck, to reduce any transmission of noise from the compressors into the building area.

5. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, and service valves for liquid and suction connections. Liquid line filter driers shall be factory provided and installed. Field installed refrigerant circuits shall include the low side cooling components, refrigerant, thermal expansion valve, liquid line and insulated suction line.

6. Unit shall include a factory holding charge of R-410A refrigerant and oil.

7. The unit shall be capable of stable cooling operation to a minimum of 35°F outdoor temperature.

8. Each refrigeration circuit shall be equipped with a liquid line sight glass.

9. Each compressor shall include a sound blanket.

H. **Compressor Motors:** Each compressor motor shall be suction gas-cooled and have a voltage utilization range of plus or minus 10 percent of nameplate voltage. Internal temperature and current-sensitive motor overloads shall protect compressors under loss of charge and other abnormal operating conditions.

I. **Condenser Coils:** Condenser coils shall be configurated aluminum fins mechanically bonded to seamless copper tubing. Subcooling circuit(s) shall be provided as standard for each refrigeration circuit. Coils shall be factory pressure and leak-tested to 425 psig air pressure. Corrosion resistant metal grilles for coil protection shall be provided.
J. **Condenser Fans**: Fans shall be vertical discharge, direct-drive type, statically and dynamically balanced, with aluminum blades and zinc-plated steel hubs. Motors shall have permanently lubricated ball bearings, built-in current and thermal overload protection and weathertight slingers over bearings. The fan motors shall be mounted in rubber isolators. Corrosion resistant fan grills shall be provided.

K. **Controls**: Unit controls shall include a fused 24-volt control power transformer, magnetic contactors for each compressor, cooling low ambient fan switches, high pressure cut-out(s), low pressure cut-out(s) and reset relays. Unit completely factory-wired with necessary controls and terminal block for connection of field control power wiring. A solid state anti-short-cycle timer shall be available for retrofit on all units to prevent rapid on-off compressor cycling in light load conditions. A time-delay relay shall be provided in all dual compressor units to prevent both compressors from coming on line simultaneously.

L. **Refrigerant/Oil Charge**: Units shall be shipped from the factory with a sufficient charge of refrigerant and oil for the complete system when used with pre-charged refrigerant lines.

M. **Refrigerant Line Connections**: Connections shall be either compression or sweat type. Brass liquid and suction line service valves, gauge/charging ports and a suction and discharge pressure gauge panel shall be provided.

N. **Warranty**: The manufacturers one year parts and labor and five year extended (non pro-rated) compressor warranty shall be provided.

O. **Warranty**: Provide for units 1 and 2; Manufacturer shall provide a limited “parts only” warranty for a period of 12 months from the date of equipment startup or 18 months from the date of original equipment shipment from the factory, whichever is less. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer’s written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance and refrigerant. Compressors shall carry a 5 warranty from date of original equipment shipment from the factory.

**PART 3 - EXECUTION**

3.1 **INSTALLATION**:

A. **General**: Install DX/Electric heat air handling units and condensing units in accordance with manufacturer's instructions, the NEC, and applicable local codes and ordinances. Test installed systems for compliance with these Specifications. Rework as required and as directed to ensure that specified and indicated requirements are met and that installed systems function as intended.

B. **Condensing Unit Mounting**: Mount units on reinforced concrete pads. Pads shall extend to a minimum of 3-1/2” above finished grade and shall be a minimum of 6” thick. Reference to Section 23 03 00 for additional requirements.

C. **Air Handling Unit Mounting**: Hang the unit from the structure with all thread and vibration isolators or set on a concrete pad.

D. **Leveling**: Install units level to operate without noticeable vibration after installation.

E. **Vibration Isolators**: Air handling units shall be installed with vibration isolators and separated from ductwork with flexible duct connections.

F. **Refrigerant Piping**: Install, test, evacuate and change refrigerant piping per the manufacturer's recommendations and as specified in Section 23 20 00.

G. **Drain Connections**: Pipe condensate directly to a primed floor drain. Provide P-traps on air handling unit condensate drain connections with seal depths at least equal to the total static pressure of the unit.
as installed. P-traps shall be constructed of pipe and tees as detailed on the Drawings. Elbows shall not be used. All unused openings of tees shall be closed with removable plugs which shall serve as cleanouts.

H. Filters: Install initial set of filters after ductwork has been blown out and prior to continuous operation of each air handling unit.

I. Coil Pull Space: Air handling units shall be installed with adequate space to allow unit coils to be removed without demolition of building construction. Coil pull space and any required demolition of building construction shall be clearly indicated on As-built Drawings. The Contractor shall insure that all field-piping, valves, ductwork, and other obstructions are not in the way or can be easily removed with flanges to facilitate coil removal.

J. Installation, Operation and Maintenance manual shall be supplied with the units.

3.2 START-UP:
A. Start-up, test, and adjust electric heaters in accordance with manufacturer's published start-up instructions. Adjust air diffusion louvers for proper air flow. Check and calibrate controls.

B. Controls: Unit controls, including, but not limited to overcurrent protection, magnetic evaporator fan and heater stage contactors, control power transformers, terminal strips, relays and a single point power entry shall be factory installed and wired in the unit such that the only field wiring required is a single power connection to the unit and control wiring to the thermostat and condensing units. Evaporator defrost control shall be provided to prevent compressor slugging by temporarily interrupting compressor operation when low evaporator coil temperatures are encountered.

3.3 TESTING AND BALANCING:
A. Refer to Section 23 05 093 for air handling unit testing and balancing.

3.4 IDENTIFICATION:
A. Refer to Section 23 03 00 for applicable painting, nameplates, and labeling requirements.

END OF SECTION 23 62 13
PART 1 - GENERAL

1.1 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, Supplementary General Conditions, all applicable requirements of Division 1, "General Requirements", and Section 230000, "Basic Mechanical Requirements", govern this Section.

1.2 DESCRIPTION OF WORK:
A. Work Included: Provide supply and exhaust fans, air intakes, and relief vents as scheduled and indicated.
B. Types: The types of fans, outside intakes and relief vents required for the project include, but are not limited to, the following:
   1. Centrifugal roof exhaust fans.
   2. Centrifugal upblast roof exhaust fans.
   5. Upblast smoke exhaust fans.
   6. Vane axial supply/exhaust fans.
   7. Air intakes.
   8. Relief vents.

1.3 QUALITY ASSURANCE:
A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
   1. Acme.
   2. Carnes Company, Inc.
   3. Cooke.
   4. Flakt Products, Inc.
   5. Greenheck Fan Corporation.
   6. Peerless.
   7. Penn Ventilator Company.
   8. Trane Company.
   9. Woods Fan Division.
B. AMCA Seals: Provide fans which are rated per AMCA standards and bear the AMCA-certified rating seal.
FANS, AIR INTAKES AND RELIEF VENTS

C. **Electrical Standards:** Provide electric motors and products which have been listed and labeled by Underwriters’ Laboratories, Inc. (UL) and comply with National Electrical Manufacturer’s Association (NEMA) standards.

1.4 **SUBMITTALS:**

A. Shop drawing submittals shall include, but not be limited to, the following:

1. Cut sheets clearly indicating fans, air intake and relief vent construction, dimensions, ratings, capacities, and accessories.
2. Cut sheets on roof curbs clearly indicating dimensions, required roof openings, and flashing details.
3. Fan curves with fan selection point clearly indicated.
4. Fan drive selection calculations.
5. Motor data as required in Section 23 04 00, "Motors and Controllers".
6. Additional information as required in Section 23 03 00.

1.5 **PRODUCT DELIVERY, STORAGE AND HANDLING:**

A. Deliver fans, intakes, vents, and accessories carefully to avoid damage to material components, enclosure, and finish.

B. Handle fans, intakes, vents, and accessories carefully to avoid damage to material components, enclosure and finish.

C. Store fans, intakes, vents, and accessories in a clean, dry space, and protect from the weather.

**PART 2 - PRODUCTS**

2.1 **GENERAL FAN REQUIREMENTS:**

A. **Ratings:** Fans shall be licensed to bear the AMCA-certified ratings seal. Ratings of fans shall be not less than the values shown on the Drawings, based on 69.8°F and 29.92" of Hg atmospheric pressure.

B. **Construction:** Fan construction shall be in accordance with AMCA classes of construction for the intended duty. Fan wheels, shafts, and drives shall be statically and dynamically balanced at the factory as a unit. Balancing shall be factory-certified.

C. **Motors:** Fan motors shall be 1750 rpm open drip-proof (ODP) or totally-enclosed, fan-coded (TEFC) type as required for the application. Motors 1 hp and larger shall be energy efficient, high efficiency type. Motors shall be selected to be nonoverloading with the fan provided. Refer to Section 23 04 00 for additional motor requirements.

D. **Drives:** Provide drives with a minimum belt horsepower capacity of 165% of the motor nameplate horsepower. All fans requiring 1-1/2 hp or larger motor shall include the fan drive selection calculations with the submittal. The selection calculations shall include the correction factor for arc of contact. The submittal data shall identify the source of the selection data.

E. **Motor Sheaves:** Motor sheaves shall be Browning Type, MVP, or approved equal, adjustable type with double locking feature. Motor sheaves shall be selected for the rated fan rpm and shall be adjustable to as close as 10% above and below the rated fan speed. Provide fixed sheaves for all motors 3 hp and larger after proper speed has been determined during system balancing.
FANS, AIR INTAKES AND RELIEF VENTS

F. **Fan Sheaves:** Provide nonadjustable sheaves with removable machined bushings. Sheaves shall be machined on all surfaces. Sheaves with over three grooves shall be dynamically balanced and the manufacturer shall so designate on each sheave. Fan sheaves with three grooves or less shall be statically balanced and weights required for balancing shall be welded to the sheaves. Manufacturers shall be Browning, Eaton, Yale and Towne, Dodge Manufacturing Company, or Fort Worth Steel and Machinery Company.

G. **Belts:** Provide standard “V-groove” belts suitable for the service intended with the required capacities. The belts shall be closely matched and tagged prior to delivery to the job site. If the belts do not appear to be properly matched during operation, they shall be rechecked and, if necessary, replaced. Belts shall be as manufactured by Gates (Preferred UH product), Durkee-Atwood, Goodyear, Browning, or Uniroyal.

H. **Speed Control:** All single phase direct drive fans shall be provided with compatible internally mounted solid state speed controllers, unless noted otherwise.

I. **Bearings:** Provide SKF, Sealmaster, Timken or Fafnir, externally or internally-mounted, grease-lubricated, self-aligning ball bearings. Bearings shall have grease type Zerk fittings and shall be selected for a minimum B-10 life as defined by AFBMA of 200,000 hours, unless specified otherwise.

J. **Motor Mounts:** Motors shall be mounted on an adjustable base rigidly supported on the fan and shall have extended shaft to accommodate the adjustable pitch sheave.

2.2 ROOF CURBS:

A. **General:** Provide prefabricated, insulated aluminum roof curbs for all roof mounted fans. Curbs shall be of welded construction and roof-over-flashing type with build-in cant and a minimum overall height of 8” above roof surface, unless otherwise noted or required to meet code requirements. Roof curbs shall be Greenheck Model #GPS or approved equal for roof decks that are not surface insulated and Model #GPR or approved equal for roof decks that are surface insulated. Damper trays shall be provided to facilitate the mounting of the backdraft dampers, where specified or scheduled. Extended base curbs shall be provided when scheduled or required.

2.3 CENTRIFUGAL ROOF EXHAUST FANS:

A. **General:** Provide Greenheck Model G, GB or approved equal ACME, Cook or Carnes centrifugal roof-mounted exhaust fans with capacities as scheduled.

B. **Construction:** Fans shall be centrifugal, belt or direct driven as scheduled. Construction of the fan housing, fan wheel and inlet cone shall be aluminum. Wheels shall be aluminum, non-overloading backward curved, centrifugal type and shall be statically and dynamically balanced to assure smooth and vibration-free operation. The entire drive assembly shall be mounted on vibration isolators. Fans shall be constructed to withstand winds up to 150 mph.

C. **Drives:** The wheel shaft on belt drive models shall be ground and polished shafting mounted in heavy duty sealed pillow block bearings. Drives shall be sized for a minimum of 165% of driven horsepower. Pulleys shall be fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. An adjustable drive shall be used for balancing and then a fixed drive shall be provided.

D. **Motors:** Motor and drives shall be isolated from the exhaust airstream and mounted on vibration isolators. Motors shall be of the heavy duty type with permanently lubricated, sealed ball bearings. Motors 1 hp and larger shall be of the high efficiency, energy efficient type.

E. **Certification:** All fans shall bear the AMCA ratings seals for both air flow and sound performance with birdscreens in place.
FANS, AIR INTAKES AND RELIEF VENTS

2.4 IN-LINE EXHAUST/TRANSFER FANS:

A. General: Provide Greenheck Model CSP, BCF, BSQ, BSQ-HP or DSQ or approved equal Acme or Cook in-line exhaust fans with capacities as scheduled.

B. Construction: Fans shall be belt or direct driven in-line type with square heavy gauge galvanized steel housing with duct mounting collars shall have a galvanized or thermally fused epoxy finish. One or both sides shall be hinged and shall support the entire drive assembly and wheel allowing the assembly to swing out for cleaning, inspection, or service without dismantling the unit in any way. On belt drive models the motor shall be mounted on the hinged side exterior, isolated from the airstream. The motor shall be isolated from the airstream by a motor enclosure and shall draw cooling air from outside the fan housing.

C. Wheels: The fan inlet shall be spun venturi throat overlapped by an aluminum backward inclined centrifugal wheel with spun cone for maximum performance. The fan wheel shall be statically and dynamically balanced.

D. Insulation: The interior of the fan housing shall have one inch (1") thick, 3 PCF density internal sound absorbing fiberglass insulation to reduce operating noise levels.

E. Drives: Motors shall be heavy duty type with permanently-lubricated, sealed ball bearings. The wheel shaft shall be ground and polished shafting mounted in heavy duty sealed pillow block bearings. Drives shall be sized for a minimum of 165% of driven horsepower. Pulleys shall be fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. An adjustable drive shall be used for balancing and then a fixed drive shall be provided. Motors shall be 1750 rpm open dripproof (ODP) type of the horsepower and voltage scheduled. Motors 1 hp and larger shall be of the high efficiency, energy efficient type.

F. Wiring: Flexible wiring leads shall be installed in conduit from the fan motor to an externally mounted junction box, motor speed controller (single phase units only) and disconnect switch, permitting access for service without disconnecting field wiring.

G. Certification: All fans shall bear the AMCA-certified ratings seal for both air and sound performance.

H. Accessories: Provide all required accessories including, but not limited to: Duct mounted automatic acting gravity type backdraft dampers of same size as fan housing, hanging support isolators with door side perpendicular to mounting surface, solid state fan speed controllers (direct drive units only) and belt guard for belt driven fans.

2.5 AIR INTAKES:

A. General: Provide ACME or approved equal Greenheck, Cook or Carnes roof-mounted air intakes with capacities as scheduled.

B. Construction: Construction of the housing shall be aluminum. Intakes shall be constructed to withstand winds up to 150 mph.

C. Accessories: Provide all required accessories including, but not limited to: aluminum birdscreen, gravity or motorized (as scheduled) backdraft dampers and prefabricated insulated aluminum roof curb.
2.6 RELIEF VENTS:

A. **General**: Provide ACME or approved equal Greenheck, Cook or Carnes roof-mounted air relief vents of the type and capacities as scheduled.

B. **Construction**: Construction of the housing shall be aluminum. Vents shall be constructed to withstand winds up to 150 mph.

C. **Accessories**: Provide all required accessories including, but not limited to: aluminum birdscreen, gravity or motorized (as scheduled) backdraft dampers and prefabricated insulated aluminum roof curb.

PART 3 - EXECUTION

3.1 INSPECTION:

A. **General**: Installer shall examine conditions under which fans, outside intakes, and relief vents are to be installed and notify Contractor in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION:

A. **General**: Install fans, outside intakes, and relief vents where shown, in accordance with manufacturer's written instructions and recognized industry practices to ensure that fans, outside intakes, and relief vents comply with requirements and serve intended purposes. Comply with NEMA standards and requirements of NEC.

B. **Curb-mounted Fans**: All fans mounted on roof curbs shall be securely attached to the roof curb with appropriate fasteners located 8” on center with a minimum of two fasteners per side by this Contractor. The roof curb shall be securely attached to the building structure by the General Contractor.

C. **Insulation**: Refer to Section 23 05 48 for fan insulation requirements.

D. **Housekeeping Pads/Vibration Isolation**: Refer to Section 23 03 00 and Section 23 05 48 for applicable requirements.

3.3 COORDINATION:

A. **General**: This Contractor shall be responsible for coordinating installation requirements and provisions with the work of other Divisions and the General Contractor.

B. Coordinate all required fan motor horsepower, voltages and locations with Electrical Contractor prior to purchase.

C. Coordinate all roof mounted fan curb openings with General Contractor prior to roofing installation.

3.4 START-UP SERVICES:

A. **General**: The fan supplier shall provide fan checkout, start-up, testing and adjusting of system components for the vane axial fan systems. The fan supplier shall also train the Owner's Engineer in the proper operation and maintenance of these fans.

3.5 TESTING:

A. **General**: Test and adjust all installed fans to verify proper operation as specified herein and as recommended by the manufacturers. Where specified hereinabove, start-up, testing, and adjustment shall be provided by a representative of the equipment supplier.

B. Refer to Section 23 05 93 for additional start-up, testing, and adjustment requirements.
3.6 IDENTIFICATION:

A. Refer to Section 23 03 00, for applicable painting, nameplates, and labeling requirements.

END OF SECTION 23 82 20
PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this
   Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. Perform all Work required to provide and install the following electric duct heaters indicated by
   the Contract Documents with supplementary items necessary for proper installation.

B. Refer to Division 26 sections for the following Work:
   1. Power supply wiring from power source to power connection on terminal unit. Include
      starters, disconnects, and required electrical devices, except where specified as
      furnished, or factory-installed, by manufacturer.
   2. Interlock wiring between electrically-operated terminal units and between terminal units
      and field-installed control devices.
   3. Interlock wiring specified as factory-installed is Work of this Section.

C. Provide the following as Work of this Section, complying with requirements of Division 26
   Sections:
   1. Control wiring between field-installed controls, indicating devices, and terminal unit control
      panels.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified
   by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be
   applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and
   standards addressed within the following references:
   2. ASHRAE Standard 33 - Methods of Testing Forced Circulation Air Cooling and Heating
      Coils.
   4. ANSI/UL 883 - Safety Standards for Fan Coil Units and Room Fan Heater Units.
   5. ANSI/UL 1025 - Electric Air Heaters.
1.04 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of electric duct heaters, of types and sizes required, whose products have been in satisfactory use in similar service for not less than three (3) years.

B. Codes and Standards:

1. Provide coil ratings in accordance with American Refrigeration Institute (ARI) Standard 410 "Forced-Circulation Air-Cooling and Air-Heating Coils".
2. Test coils in accordance with American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 33 "Methods of Testing Forced Circulation Air Cooling and Heating Coils".
3. Provide electrical components for terminal units, which have been listed and labeled by UL.

1.05 SUBMITTALS

A. Product Data:

1. Submit manufacturer's data for duct heaters showing dimensions, capacities, ratings, performance characteristics, gages and finishes of materials, and installation instructions.

B. Record Documents:

1. Manufacturers wiring diagrams detailing electrical connection to duct heaters for wiring for power, signal, and control systems, differentiating clearly between manufacturer-installed wiring and field-installed wiring.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to the Project Site under provisions of Division 01 and Division 20.

B. Accept products at the Project Site in factory-fabricated protective containers or coverings, with factory-installed shipping skids. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

D. Check and maintain equipment on a monthly basis to ensure that equipment is being stored in accordance with manufacturer’s recommended practices. Storage records shall be maintained that indicate these requirements have been met.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Electric duct heaters of types, sizes, ratings, and characteristics indicated.
C. Heating Elements: Open coil of resistance wire, 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings. Recess bushings into casing opening and fasten to supporting brackets. Mounted in galvanized-steel frame.

D. Coil Layout: Horizontal (air flow vertical) or Vertical (air flow horizontal).

E. Casing Assembly: Slip-in type, galvanized-steel frame.

F. Over-Temperature Protection:
   1. Serviceable through terminal unit without removing heater from duct or unit.
   2. Disk-type, automatic reset, thermal-cutout safety devices for primary over-temperature protection.
   3. Load carrying, manual reset or manually replaceable thermal cutouts, factory wired in series with each heater stage for secondary protection.
   4. Airflow switch, diaphragm operated differential pressure switch to prevent duct heater from operating when there is no air flow.

G. Control Panel: Mounted on unit, with means of a safety disconnect and overcurrent protection. Include the following controls:
   1. Magnetic contactor.
   2. Silicon-Controlled Rectifier (SCR) or Step controller with integrated Vernier Stage using 4 to 20 ma or 1 to 10 Volt input signal.
   3. Time-delay relay.
   4. Pilot lights; one per step, “power on”, and “low air flow”.
   5. Provide common ohmic voltage and milli-amp alarm signals to the building automation system (BAS).
   6. Provide single point power connection.

H. Permanently attach a separate, complete, and specific wiring diagram to each heater. Typical wiring diagrams are not acceptable. Clearly mark power and control terminals in terminal unit identical to the wiring diagram.

2.02 MANUFACTURERS

A. Chromalox.

B. Indeeco.

C. Markel Products Co.

D. Nailor Industries, Inc.

E. Trane Inc.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.
C. Inspect areas and conditions under which terminal units are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to installer.

D. Do not operate electric heaters for any purpose until ductwork is clean of any possible debris.

E. Maintain minimum working clearances around the heater electrical panel in accordance with NEC Article 110.

F. Install duct heaters in metal ducts and casings constructed according to SMACNA “HVAC Duct Construction Standards.”

G. If applicable, anchor duct heaters in position using suitable supports.

H. Connect duct heaters and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals’, including screws and bolts, according to equipment manufacturer’s published torque-tightening values for equipment connectors. Where manufacturer’s torque requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL 486A.

I. After construction is completed, including painting, clean unit's exposed surfaces and vacuum clean electric duct heaters and inside of cabinets.

J. Touch up scratches and marks from handling and placement of equipment with masking enamel to match manufacturer's color. Refer to Division 09 for Site-applied finishes.

END OF SECTION 23 82 33
1.1 RELATED DOCUMENTS:

   A. Drawings and general provisions of the Contract, including TPWD’s Uniform General
      Conditions and Supplementary General Conditions and Division 1 General
      Requirements, apply to this section.

1.2 DESCRIPTION OF WORK:

   A. **Work Included**: This Work of this Division includes the furnishing of all supervision, labor,
      materials, supplies, equipment, fixtures, apparatus, appurtenances, transportation,
      storage, utilities, permits and licenses required for complete installation of complete,
      tested and operating electrical systems as shown on the drawings and specified or as
      reasonably inferred there from, in place and ready for service. All work performed under
      this Section shall be performed in a workmanlike manner in accordance with the
      Drawings and Specifications and industry standards and subject to the terms and
      conditions of the Contract. For purposes of these Specifications, “provide” and “furnish
      and install” shall be synonymous.

   B. **Drawings**: Refer to the Electrical Drawings for graphic representations, schedules, and
      notations of required electrical work.

   C. **Specifications**: Refer to this Division and related Divisions for the primary technical
      specifications of electrical work.

   D. **Work of Other Sections**: Requirements given within this Section apply to the Work of all
      Sections of this Division. The actual performance of the Work stays within the Section in
      which it occurs; but subject to the requirements of this Section to the extent applicable.

5. Finish painting of electrical systems in areas exposed to the view of
   building occupants is specified in other Divisions.

6. Installation of electrical control power which is not specified as an integral part of
   equipment specified under Divisions 22 and 23 shall be provided under this
   Division.

7. Access doors in finished surfaces shall be provided under this Division and
   installed by the Contractor installing the finished surface. Locations are shown
   on the Drawings and as required for proper equipment access.

8. Concrete housekeeping pads, curbs and supporting structures are specified
   under this Division. Dimensions and locations of pads and supports shall be the
   responsibility of this Division.

9. Owner and General Contractor-furnished equipment is furnished and installed
   under other Divisions. Proper electrical provisions, including rough-in and final
   equipment connections, are included in the Work of this Division.

10. Motors for all equipment shall be furnished and installed by the Division(s)
    providing the equipment.

11. Motor starters and controllers that are furnished as an integral part of the
    equipment shall be furnished and installed by the Division(s) shall be wired and
    connected by this Division.

12. Variable speed drives which are furnished with controlled equipment shall be
    provided by the Division(s) providing the equipment to this Division for
    installation, wiring and connections by this Division.
9. All other motor starters and associated electrical wiring and connections are included in the Work of this Division.

E. Texas Parks and Wildlife (TPWD) Uniform General Conditions (UGC): Contractor is responsible for following all requirements in the owners (TPWD) UGC. The stricter of these requirements or the owners UGC requirements shall be followed. Where UGC is in conflict with these specifications the contractor shall submit an RFI asking for direction from the Engineer. Where requirements are in the UGC but not in these specifications the UGC requirements shall be followed.

1.3 CODES, PERMITS AND FEES:

A. **General**: Comply with the most recently revised versions of applicable laws, rules, regulations, and ordinances of federal, state, and local utilities and authorities. Where alterations to and deviations from the Contract Documents are required by said authority, report the requirements and secure approval before starting work. Obtain all applicable permits, licenses and inspections and pay all fees charged by above authorities.

B. **Code Design Basis**: Refer to 1.15 in Division 1 General Requirements, Section 01000 Special Conditions for the list of codes applicable to this project.

C. **Precedence**: Where Contract Document requirements are in excess of Code requirements and are permitted under the Code, the Contract Documents shall govern. None of the terms or provisions of the Drawings or specification shall be construed as waiving any of the rules, regulations or requirements of these authorities. In the event of conflict between the Contract Documents and the local enforcing authority, the latter shall rule. Any modifications resulting there from shall be made without additional cost to the Owner or Engineer. This Contractor shall report any such modifications to the Engineer and secure his approval before proceeding.

1.4 QUALITY ASSURANCE AND STANDARDS:

A. **Materials/Methods**: Manufacturers, materials, and methods described in the various sections of the Specifications, and indicated on the Drawings are intended to establish a standard of quality only. It is not the intention of the Engineer to discriminate against any product, material or method that is equal to the standards as indicated and/or specified, nor is it intended to preclude open, competitive bidding. The fact that a specific manufacturer is listed as an acceptable manufacturer should not be interpreted to mean that the manufacturers’ standard product will meet the requirements of the project design, Specifications and space constraints. The Engineer shall be the sole judge of quality and equivalence of equipment, materials and methods.

B. **Alternative Products/Materials/Methods**: Products by other reliable manufacturers, other materials, and other methods may be accepted provided they have equivalent capacity, construction, and performance. Wherever a definite product, material or method is specified and there is not a statement that another product, material or method will be acceptable, it is the intention of the Engineer that the specified product, material or method is the only one that shall be used without prior approval. Wherever a definite material or manufacturer's product is specified and the Specification states that products of similar design and equal construction from the specified list of manufacturers may be provided, it is the intention of the Engineer that products of manufacturers that are specified are the only products that will be acceptable and that products of other manufacturers will not be considered for substitution without prior written approval.

C. **Alternative Equipment**: Where substituted or alternative equipment is used on the project, it shall be the responsibility of the Contractor or Subcontractor involved to verify that the equipment will fit in the space available, including all required Code and
maintenance clearances, and to coordinate all equipment requirements and provisions with the Electrical Design and all other Contractors and Subcontractors.

D. **Compatibility:** Provide products which are compatible with other products of the electrical work, and with other work requiring interface with the electrical work, including electrical connections and control devices. For exposed electrical work, coordinate colors and finishes with other work. Determine in advance of purchase that equipment and materials proposed for installation will fit into the confines indicated, leaving adequate clearance as required by applicable codes and for adjustment, repair, and replacement.

E. **Standards:** Refer to paragraph 1.15 of Division 1 General Requirements, Section 01000 Special Conditions for general administrative/procedural requirements related to compliance with applicable standards. This Work and all materials shall meet the standards set forth in the applicable portions of the following recognized standards:

1. **AEIC** Association of Edison Illuminating Companies.
2. **ANSI** American National Standards Institute.
4. **ASME** American Society of Mechanical Engineers.
5. **ASPE** American Society of Plumbing Engineers.
6. **ASSE** American Society of Sanitary Engineering.
8. **AWS** American Welding Society.
9. **CBM** Certified Ballast Manufacturers.
10. **CDA** Copper Development Association.
11. **CE** Corps of Engineers (U.S. Department of the Army).
12. **EIA** Electronic Industry Association.
13. **ETL** Electrical Testing Laboratory.
14. **FAA** Federal Aviation Administration (US Department of Transportation).
15. **FCC** Federal Communications Commission.
17. **FS** Federal Specification (General Services Administration).
18. **ICEA** Insulated Cable Engineering Association.
19. **IEEE** Institute of Electrical and Electronics Engineers.
21. **IRI** Industrial Risk Insurers.
22. **LPI** Lighting Protection Institute.
24. **MSS** Manufacturers Standardization Society of the Valve and Fittings Industry.
25. **NEC** National Electrical Code (by NFPA).
27. **NEMA** National Electrical Manufacturers Association.
29. **OSHA** Occupational Safety Health Administration (US Department of Labor).
30. **UL** Underwriters’ Laboratories, Inc.

1.5 **SITE VISIT AND FAMILIARIZATION:**

A. **General:** Become familiar with the Drawings and Specifications, examine the premises, and understand the conditions under which the Contract shall be performed, prior to submitting a bid.

B. **Site:** Be informed of the site conditions, verify locations of new and existing equipment, and determine exact requirements for connections.
1.6 DRAWINGS AND SPECIFICATIONS:

A. General: The Drawings are schematic in nature and indicate approximate locations of the electrical systems, equipment, fixtures and devices, except where specific locations are noted and dimensioned on the Drawings. All items are shown approximately to scale. The intent is to show how these items shall be integrated into the building. Locate all items by on the job measurements and in accordance with the Contract Documents. Cooperate with other trades to ensure project completion as indicated.

B. Location: Prior to locating electrical devices, light fixtures, and other items, obtain the Architect/Engineer's approval as to exact location. Locations shall not be determined by scaling Drawings. Mount lighting fixtures and electrical devices at the heights directed by the Architect/Engineer. Where there is a question concerning the required location for items of electrical work, the Contractor shall submit a request for information to the Architect/Engineer requesting specific directions for locating the item. Contractor shall be responsible for costs of redoing work of trades necessitated by failure to comply with this requirement.

1. All electrical devices, lighting fixtures, and other devices shall be referenced to coordinated, established data points and shall be located to present symmetrical arrangements with these points and to facilitate the proper arrangements of building construction details, acoustical tile panels and other building features with respect to the mechanical and electrical outlets and devices. Electrical devices, fixtures, and outlets shall be referenced to such features as wall and ceiling furrings, balanced border widths, masonry joints, etc. Outlets in acoustical tile shall occur symmetrically in tile joints or in the centers of whole tiles and the exact location of each outlet and the arrangements to be followed shall be acceptable to the Architect/Engineer. Outlets in wall tile or masonry construction shall occur symmetrically in the centers of whole tiles, bricks, or blocks and the exact location of each outlet and the arrangement to be followed shall be acceptable to the Architect/Engineer.

2. The Drawings show diagrammatically the location of the various outlets and apparatus. Exact locations of these outlets and apparatus shall be determined by reference to the Architectural Drawings and to all detail Drawings, equipment Drawings, rough-in Drawings, etc., by measurements at the building, and in cooperation with the other trades. The Owner and Architect/Engineer reserve the right to make any reasonable change in location of any outlet or apparatus before installation, without additional cost to the Owner.

C. Specifications: The specifications are intended to supplement the Drawings and it is not in the scope of the specifications to mention any part of the work which the Drawings are competent to fully explain. Conversely, any part of the work which the specification are competent to fully explain, may not be mentioned on the Drawings.

D. Disagreement: Disagreement between the Drawings or specifications or within the Drawings or specifications shall be estimated using the better quality or greater quantity of material or installation, and a request for information shall be made to the Engineer.

1.7 DISCREPANCIES:

A. Clarification: Clarification shall be obtained before submitting a proposal for the Work under this Division as to discrepancies or omissions from the Contract Documents or questions as to the intent thereof.

B. Detailed Instructions: Should it appear that the work hereby intended to be done or any of the materials relative thereto, is not sufficiently detailed or explained in the Drawings or
Specifications, then the Contractor shall submit a request for information to the Engineer for such further Drawings or explanations as may be necessary before proceeding, allowing a reasonable time for the Engineer to respond. The Contractor shall conform to this additional information as a part of the Contract without additional cost to the Owner or Engineer.

C. **Interpretations**: Should any doubt or question arise respecting the true meaning of Drawings or Specifications, reference shall be made to the Engineer, whose written decision shall be final and conclusive. No alleged statement by the Engineer will be accepted as an excuse for inferior work.

D. **Contractor Agreement**: Consideration will not be granted for misunderstanding of the amount of work to be performed. Submission of a bid conveys full Contractor agreement of the items and conditions specified, shown, scheduled, or required by the nature of the project.

1.8 **UTILITIES**:

A. **General**: Utility information shown on the Drawings have been shown based upon data obtained from the site survey and the agencies having jurisdiction and are accurate to the best of the knowledge of the Engineer.

B. **Coordination**: The Contractor shall be responsible for field verification of the actual location of site and/or building utilities and shall make modifications necessary for connection to or construction around those utilities at no additional cost to the Owner or Engineer.

1.9 **TEMPORARY FACILITIES**:

A. **General**: Refer to Uniform General Conditions for requirements concerning temporary electrical facilities.

B. Provide power distribution system sufficient to accommodate construction operations requiring power, use of power tools, electrical heating, lighting, and start-up/testing of permanent electric-powered equipment prior to its permanent connection to electrical system. Provide proper overload protection. Ground fault circuit interrupters (GFCI) are to be used on all 120-volt, single-phase, 15, 20, and 30 amp receptacle outlets where portable tools and equipment are used. Ground fault circuit interrupters shall be tested weekly by the Contractor.

C. Temporary power feeders shall originate from a distribution panel. The conductors shall be multi-conductor cord or cable per NEC for hard and extra-hard service multi-conductor cord.

D. Branch circuits shall originate in an approved receptacle or panelboard. The conductors shall be multi-conductor cord or cable per NEC for hard and extra-hard service multi-conductor cord. Each branch circuit shall have a separate neutral and equipment grounding conductor.

E. All receptacles shall be of the grounding type and electrically connected to the grounding conductor.

F. Provide temporary lighting by factory-assembled lighting strings or by manually-assembled units. All lamps for general lighting shall be protected from accidental contact or breakage. Protection shall be provided by installing the lights a minimum of 7 feet from the work surface or by lamp holders with guards. Branch circuits supplying temporary lighting shall not supply any other load. Provide sufficient temporary lighting to ensure proper workmanship by combined use of day lighting, general lighting, and portable plug-in task lighting. Comply with OSHA required foot-candle levels.
G. For temporary wiring over 600 volts, suitable fencing, barriers, or other effective means shall be provided to prevent access of anyone other than authorized and qualified personnel.

H. Temporary power cords shall be kept off the ground or floor. The Contractor shall provide temporary supports as required to keep temporary cords off the ground or floor.

1.10 CHANGE ORDERS:
A. **General:** Refer to TPWD Uniform General Conditions for requirement concerning Change Orders.

1.11 SUBSTITUTIONS:
A. **General:** Refer to TPWD Uniform General Conditions for information concerning substitutions.

1.12 PRECONSTRUCTION CONFERENCE:
A. **Conference:** Refer to TPWD Uniform General Conditions, Article 3.1.1 for preconstruction conference requirements.

1.13 SITE OBSERVATION:
A. **General:** Observation at the site to verify general compliance with Contract Documents shall be made periodically by the Engineer or his representative. Written observation comments shall be submitted to the General Contractor for review and a written response.

1.14 REQUESTS FOR INFORMATION (RFI):
A. **General:** All Contractor Requests for Information (RFI's) shall be submitted to the Engineer in writing, for response.

1.15 SUBMITTALS:
A. **General:** Submittals required for this project shall include, but not be limited to:
   1. Shop Drawings and Product Brochure Submittals.
   2. Certifications and Test Reports.
   3. Operating and Maintenance Manuals.
   4. Warranties (Guarantees).

B. **Refer to TPWD Uniform General Conditions for additional submittal requirements.**

C. **Shop Drawings and Product Brochure Submittals:** The Contractor shall submit one electronic (unprotected pdf format) copy or a sufficient number of complete bound hardcopy sets of Shop Drawings and complete data covering each item of equipment or material. The terms "Submittal" and "Shop Drawing" in this Specification are defined as either product literature, samples of equipment, or actual Shop Drawings. The first submittal of each item requiring a submittal must be received by the Engineer within 90 days of contract award. The Engineer shall not be responsible for any delays or costs incurred due to excessive Shop Drawing review time where the first submittal is received more than 90 days after contract award. The Architect [, Owner,] and Engineer will each retain one copy of all hardcopy Shop Drawing submittals for their files. The Contractor is required to include a copy of all final electrical Shop Drawing submittals in Electrical O&M manuals.
   1. Contractor shall prepare complete submittals that include all pertinent information about the product. A single Shop Drawing shall not contain information from more than one Specification section, but a single Specification section may be
subdivided into separate submittals for items or equipment that are specified in that section. Shop Drawings shall be separately bound by complete or partial Specification section. Where a single Shop Drawing contains information from more than one Specification section, it will be marked "REVISE AND RESUBMIT" and returned. Each Shop Drawing shall include the following items enclosed in a suitable binder. Shop Drawings that do not comply with the above requirements will be marked "REVISE AND RESUBMIT" and returned to the Contractor:

a. An index page with a listing of all data included in the submittal.
b. A list of variations. This page shall list all variations, including unfurnished or additional items or features between the submitted equipment and the specified equipment. If there are no variations, then this page shall state "No Variations". Where variations affect the work of other contractors, then the contractor shall certify on this page that these variations have been fully coordinated with the affected contractors and that all additional costs to the affected contractors associated with the variations shall be paid by the submitting contractor.
c. Equipment information including manufacturer's name and designation, size, performance and capacity data. All applicable listings, labels, approvals and standards shall be clearly indicated.
d. Dimensional data and actual sketches as applicable to show that the submitted equipment will fit the space available with all required Code and maintenance clearances.
e. Identification of each item of material or equipment matching that indicated on the Drawings.
f. Sufficient pictorial, descriptive and diagrammatic data on each item to show its conformance with the Drawings and Specifications. Any options or special requirements shall be so indicated. All applicable information shall be clearly indicated with arrows or another approved method. Any non-applicable information shall be crossed out.
g. Additional information as required in other sections of this Division.
h. Certification by the General Contractor and Subcontractor that the material submitted is in accordance with the Contract Documents, signed and dated.
i. Reports or information requiring certification shall be certified by an authorized officer of the manufacturer or testing agency.
j. Certified Shop Drawings showing dimensions, loading details, anchor bolt locations, and inserts required for each piece of equipment set on concrete in sufficient time to cause no delay in the Work.
k. Equipment and material submittals shall show sufficient data including all performance data, recommended installation details, and sufficient data to indicate complete compliance with the Contract Documents, including proper sizes, clearances, capacities, materials, and finishes.

D. Required Shop Drawing Submittals: Submit Shop Drawings, including, but not limited to the following items. Refer to individual specification sections for specific submittal requirements.

1. Electrical Testing Refer to Section 260125.
2. Basic Materials and Methods Refer to Section 260501.
3. Low Voltage Conductors and Cable Refer to Section 260519.
4. Electrical Grounding Refer to Section 260526.
5. Electrical Raceways Refer to Section 260533.
6. Electrical Boxes Refer to Section 260534.
7. Identification for Electrical Systems Refer to Section 260553.
8. Short Circuit Analysis/Coordination Study Refer to Section 260573.
9. Low-Voltage Lighting Control Refer to Section 260926.
10. Low Voltage Transformers Refer to Section 262200.
11. Panelboards Refer to Section 262416.
12. Electrical Service Entrance Refer to Section 262701.
13. Equipment Wiring Refer to Section 262717.
14. Wiring Devices Refer to Section 262726.
15. Enclosed Circuit Breakers Refer to Section 262817.
16. Enclosed Switches Refer to Section 262818.
17. Surge Protective Devices (SPDs) Refer to Section 264313.
18. Indoor Lighting Refer to Section 265100.
19. Addressable Fire Alarm System Refer to Section 283100.
20. Coordination Drawings as required by this Section.

E. Shop Drawing Submittal Review: Shop Drawings will be reviewed for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Any action shown in review comments is subject to the requirements of the Contract Documents. The submitting Contractor is responsible for: dimensions which shall be confirmed at the job site; fabrication processes and techniques of construction; coordination of his work with that of all other trades; and the satisfactory performance of his work.

1. The Engineer will endeavor to provide a Shop Drawing review time in the Engineer's office in a timely manner, exclusive of transmittal time, and this review time shall be considered by the Contractor when scheduling his work on the project.

2. The Architect's review or approval and the Engineer's review of Shop Drawings shall not relieve the Contractor of the responsibility for errors, omissions or deviations that may be contained in the submittals. If the Contractor proceeds on the basis of undetected errors, omissions or deviations in reviewed Shop Drawings, it shall be at his sole responsibility and the review does not allow deviations from the requirements of the Contract Documents. Noting some errors, omissions, and deviations but overlooking other errors, omissions, and deviations does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawing or the Engineer's review thereof, the Contract Documents shall govern the Work and are neither waived or superseded by the Shop Drawing review.

3. It shall be the responsibility of the submitting Contractor to check all equipment and materials for conformance with the Contract Documents and "REVIEWS WITH NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED" submittal at the time such equipment and materials are delivered to the job site, and to notify the Engineer of any deviations.

4. Inadequate or incomplete Shop Drawings will not be reviewed by the Architect or the Engineer and will be returned to the Contractor marked "REVISE AND RESUBMIT" for completion and resubmittal.

5. Shop Drawings will be marked "REVIEWS WITH NO EXCEPTIONS TAKEN", "MAKE CORRECTIONS NOTED", "MAKE CORRECTIONS NOTED AND SUBMIT WRITTEN RESPONSE", "REVISE AND RESUBMIT" or "REJECTED"
when reviewed by the Engineer. The definitions of these terms for review purposes is as follows:

a. REVIEWED WITH NO EXCEPTIONS TAKEN - The Shop Drawing was reviewed and no exceptions from the general conformance with the design concept and general compliance with the information given in the Contract Documents were noted.

b. MAKE CORRECTIONS NOTED - The Shop Drawing was reviewed and found to have minor deviations from the requirements of the Contract Documents, as noted. A Shop Drawing resubmittal is not required, however, the furnished material/systems shall comply with the corrections noted in the submittal review.

c. MAKE CORRECTIONS NOTED AND SUBMIT WRITTEN RESPONSE - The Shop Drawing was reviewed and found to have either minor deviations from the requirements of the Contract Documents or information missing from the submittal, as noted. A complete Shop Drawing resubmittal is not required, however, a written response to all review comments shall be submitted in the format used for a resubmittal.

d. REVISE AND RESUBMIT - The Shop Drawing was reviewed and major deviations from general conformance with the design concept and general compliance with the information given in the Contract Documents were observed, as noted. The Shop Drawing shall be revised to eliminate the deviations noted and resubmitted.

e. REJECTED - The Shop Drawing was reviewed and is not in general conformance with the design concept or in compliance with the information given in the Contract Documents, as noted. A revised Shop Drawing submittal for the specified equipment or materials shall be resubmitted.

6. Materials and equipment which are purchased or installed without a "REVIEWED WITH NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED" Shop Drawing review shall be at the risk of the Contractor and the cost for removal and replacement of such materials and equipment and related work which is judged unsatisfactory by the Architect/Engineer for any reason, shall be at the expense of the Contractor.

7. Shop Drawings shall be complete and checked prior to submission to the Engineer for review.

F. Certifications and Test Reports: The Engineer may, at their option, witness any or all on and off-site acceptance and operational testing. Submit a detailed listing of certification and testing for each system indicating estimated dates for completion of system installation. This listing of certification and testing shall be submitted at least 30 days before any testing is conducted. All testing shall also be witnessed by a TPWD representative. All test results shall be documented in writing and signed by the appropriate craftsman such as the electrician, fire alarm technician, etc.

1. Test procedures and test result reporting forms shall be submitted for review no later than the date of the certification and testing listing submittal.

2. Notify the Engineer in writing two weeks prior to all scheduled testing to allow time for Engineer to schedule witnessing of testing, where elected by the Engineer.

3. Submit four copies of all certifications and test reports to the Engineer for review adequately in advance of completion of the Work to allow for remedial action as required to correct deficiencies discovered in equipment and systems.
4. Certifications and test reports to be submitted shall include, but not be limited to those items outlined in Section 260125 “Electrical Testing”.

G. Operating and Maintenance Manuals: Submit two copies of Operating and Maintenance Manuals to the Engineer for approval prior to the beginning of operator training. Provide four approved Operating and Maintenance Manuals for use in operator training. Manuals shall be bound in rigid cover, 3-ring binders with spine and cover labels and shall provide operating and maintenance information for every piece of equipment furnished under this Specification. All sections shall be typed and indexed into sections and labeled for easy reference. Bulletins containing information about equipment which is not installed on the project shall be properly marked up or stripped and reassembled. All pertinent information required by the Owner for proper operation and maintenance of applicable equipment supplied by Division 26, 27 and 28 shall be clearly and legibly set forth in memoranda which shall, likewise, be bound with bulletins. As a minimum, the following information shall be provided as applicable:

1. Complete description of each system, item of equipment, and apparatus provided under this Division, including ratings, capacities, performances, data and curves, characteristics identifying name and number, locations, and wiring diagrams, including sources for all parts.

2. Fully detailed parts lists, including all numbered parts and recommended spare parts, of each item of equipment and apparatus provided under this Division.

3. Manufacturer's printed instructions describing operation, service, maintenance, and repair of each item of equipment and apparatus.

4. Typed record of tests made of materials, equipment, and systems included under this Division. Such records shall state the dates the tests were conducted, name(s) of person(s) making and witnessing the tests, and citing any unusual conditions relevant to the tests.

5. Identifying names, name tags designations and locations for all equipment.

6. Fuse and motor heater information including location and use.

7. Equipment and motor nameplate data.

8. Copies of all approved Shop Drawing submittals.


10. Equipment and device bulletins and cutsheets clearly highlighted to show equipment installed on the project and including performance curves and data as applicable.

11. Maintenance instructions clearly highlighted to show all required periodic maintenance and lubrication.

12. Wiring diagrams.

13. Operating instructions clearly highlighted to show proper operating procedures for all equipment.

14. Exploded parts views and parts lists for all equipment and devices.

15. Color coding charts for all painted equipment and conduit.

16. Location and listing of all spare parts and special keys and tools furnished to the Owner.

H. Tools: Provide and deliver to the Owner's authorized representative any special tools required for maintenance of systems, equipment, and apparatus installed under this Division prior to requesting final acceptance of the installation.

1.16 PROJECT RECORD DOCUMENTS:

A. Refer to TPWD Division 1 General Requirements for requirements related to “as-constructed drawings” or Record Documents.
1.17 COORDINATION OF ELECTRICAL WORK:

A. General: It is recognized that the Contract Documents are diagrammatic in showing certain physical relationships which must be established within the electrical work, and in its interface with other work including utilities and mechanical work and that such establishment is the exclusive responsibility of the Contractor. The Drawings show diagrammatically the sizes and locations of the various conduit and raceway systems and equipment items and the sizes of the major interconnecting distribution, without showing exact details as to elevations, offsets, control lines, and installation details.

1. Arrange electrical work in a neat, well organized and workmanlike manner with services running parallel with primary lines of the building construction and with a minimum of 7’ overhead clearance where possible.

2. The Contractor shall carefully lay out his work at the site to conform to the architectural and structural conditions, to avoid obstructions and to provide proper grading of lines. Exact locations of outlets, apparatus and connections thereto shall be determined by reference to detail Drawings, equipment Drawings, roughing-in Drawings, etc., by measurements at the building and in cooperation with other Contractors and in all cases shall be subject to the approval of the Engineer. Relocations necessitated by the conditions at the site or directed by the Engineer shall be made without any additional cost to the Owner or Engineer.

3. All conduit and boxes except those in the various equipment rooms, in unfinished spaces or where specifically designated herein or on the Drawings shall be run concealed in furrings, plenums and chases. Wherever conditions exist which would cause any of these items to be exposed in finished spaces, the Contractor whose work is involved shall immediately call the situation to the attention of the Engineer and shall stop work in those areas until the Owner's Representative or General Contractor directs the resumption of the work. Submit for approval a Shop Drawing for any change in equipment placement, etc.

4. Equipment has been chosen to fit within the available space with all required Code and maintenance clearances and shall be installed as shown. Every effort has been made to also accommodate equipment of other approved manufacturers, however since equipment and access space requirements vary, the final responsibility for installation access and proper fit of substituted equipment rests with the Contractor.

5. System interferences shall be handled by giving precedence to pipe lines which require a stated grade for proper operation. Where space requirements conflict, the following order of precedence shall, in general, be observed:

a. Building lines.
b. Structural members.
c. Soil and drain piping.
d. Steam and condensate piping.
e. Sprinkler piping.
f. Vent piping.
g. Supply ductwork.
h. Exhaust ductwork.
i. Chilled water and heating hot water piping.
j. Domestic water piping.
k. Electrical conduit.

6. Locate electrical equipment properly to provide easy access. Arrange entire electrical work with adequate code access for operation and maintenance.
7. Advise other trades of openings required in their work for the subsequent move in of large units of electrical work (equipment).

8. Coordinate all items which will affect the installation of the work of this Division. This coordination shall include, but not be limited to: voltage, ampacity, capacity, electrical connections, space requirements, sequence of construction, building requirements and special conditions.

9. When submitting Shop Drawings on the project, this Contractor is indicating that all necessary coordination has been completed and that the systems, products and equipment submitted can be installed in the building and will operate as specified and intended, in full coordination with all other Contractors and Subcontractors.

B. Coordination Drawings:

1. Coordinate the work of all Subcontractors for this Division with the Contractors and Subcontractors responsible for this and other Divisions. Provide, in writing (with copies to the Engineer, Architect and Owner) all information necessary for coordination to permit the work of the project, including all Divisions, to be installed satisfactorily and with the least possible interference or delay.

2. This Division's Contractors, in coordination with Contractors responsible for other Divisions, shall prepare a complete set of construction "Coordination Drawings" which shall be completed and submitted to the Engineer, Architect and Owner within one (1) months after notice to proceed is given to the General Contractor. If the General Contractor or any Subcontractor allows any work to be installed before coordinating with the work of other Subcontractors, the necessary changes for field coordination shall be made without extra cost to the Owner, Architect or Engineer.

3. "Coordination Drawings" shall be drawn at a scale of not less than 1/4" = 1'0" and shall be originals or CAD plots. Drawings shall show actual equipment being provided and shall maintain all design drawing space allocations, designated dimensions, ceiling heights, chase dimensions, room sizes and required service clearances for the actual equipment being provided. Deviations from ceiling heights, chase dimensions, room sizes and similar requirements to the Construction Documents shall not be made without specific prior written authorization from the Architect.

4. "Coordination Drawings" for interior construction shall show the coordinated locations for equipment, ductwork, piping, busway, devices, etc. and shall show all ductwork, all busway and all pipe and conduit larger than 4" using double lines. Elevations shall be shown for all construction and horizontal dimensions from major construction to accessible column or building lines shall be shown. Where required for coordination, offsets shall be shown and sections shall be cut and drawn.

5. "Coordination Drawings" shall indicate loads and anchor/support points for all piping 8" and larger, for all racked piping, for all racked conduit 3" and larger, for all busway and for all suspended equipment. These drawings shall be submitted to the Structural Engineer for review and approval. Any special hangers, embeds, supports, reinforcing, etc. required by the Structural Engineer shall be provided at no additional cost to the Owner.

6. "Coordination Drawings" for all work routed underground or embedded in concrete shall show specific dimensions to accessible column or building lines and the burial depth of all underground utilities. Where existing utilities are located in the area where new utilities are being installed, dimensions and burial depth for existing utilities shall be shown on "Coordination Drawings".
7. Prior to submittal, each "Coordination Drawing" shall be completed and signed off by the General Contractor and all applicable Subcontractors prior to the submission to the Architect, Engineer and Owner and prior to installation of Division 22, 23, and 26 work in the area covered by the specific coordination drawing.

8. The requirement for "Coordination Drawings" shall not be construed as releasing the General Contractor or Subcontractors from their responsibility to coordinate the installation of the work or as authorization for the General Contractor or Subcontractors to make unauthorized changes to the Construction Documents or the project design concepts.

1.18 MATERIALS AND WORKMANSHIP:

A. **General**: Materials and equipment shall be new, of best grade and quality, and standard products of reputable manufacturers regularly engaged in the production of such materials and equipment.

B. **Workmanship**: Work shall be executed and materials installed in accordance with the best practice of the trades in a thorough, substantial, workmanlike manner by competent workmen, presenting a neat appearance when completed.

C. **Manufacturer's Recommendations**: With exceptions as specified or indicated on the Drawings or in the Specifications, apply, install, connect, erect, use, clean, and condition manufactured articles, materials, and equipment per manufacturer's current printed recommendations. Copies of such printed recommendations shall be kept at the job site and made available as required.

1.19 SPACE REQUIREMENTS:

A. **General**: Determine in advance of purchase that the equipment and materials proposed for installation will fit into the confines indicated, leaving adequate code clearances for adjustments, repair, or replacement.

B. **Clearance**: Allow adequate space for clearance in accordance with requirements of the Code and local inspection department.

C. **Scheduled Equipment**: The design shown on the Drawings is based on the equipment scheduled.

D. **Responsibility**: Since space requirements and equipment arrangement vary for each manufacturer, the responsibility for initial access and proper fit rests with the Contractor.

E. **Review**: Final arrangements of equipment to be installed shall be subject to the Architect's review.

1.20 SAFETY REGULATIONS:

A. All electrical work shall be performed in compliance with all applicable and governing safety regulations. All safety lights, guards, signs, and other safety materials and provisions required for the performance of the electrical work shall be provided by and operated by the Electrical contractor.

1.21 DELIVERY, STORAGE AND HANDLING OF MATERIALS:

A. **General**: Protect all materials and equipment to be installed under this Division from physical and weather damage.

B. **Scope**: Work under this Division shall include, but not limited to:

1. Shipping from point of manufacture to job site.
2. Unloading, moving, and storage on site with proper protection as required to properly protect equipment from rust, drip, humidity, dust, or physical damage.
3. Hoisting and scaffolding of materials and equipment included in this Division.
4. Ensuring safety of employees, materials, and equipment using such hoisting equipment and scaffolding.

C. Coordination: All large pieces of apparatus which are to be installed in the building and which are too large to permit access through doorways, stairways or shafts shall be brought to the job by the Contractor and shall be placed in the spaces before enclosing partitions and structure are completed. All apparatus shall be cribbed up from the floor by Contractor and shall be covered with tarpaulins or other protective covering where required for protection.

1.22 NOISE AND VIBRATION:

A. General: Warrant the electrical systems, and their component parts to operate without objectionable noise or vibration. Noise from systems or equipment which results in noise within occupied spaces above the recommended NC curves (refer to ASHRAE Standard) shall be considered objectionable. Vibration shall not be apparent to the senses in occupied areas of the building. Objectionable noise, vibration, or transmission thereof to the building shall be corrected.

1.23 CLEANING, ADJUSTING AND START-UP:

A. Start-up Services: Where specified for any individual item of electrical equipment, provide a factory-authorized representative for testing, start-up of equipment, and instruction of Owner's operating personnel. Certify that these services have been performed by including a properly executed invoice for these services or a letter from the manufacturer.

B. Testing: Refer to Section 260125, "Electrical Testing" for requirements.

C. Clean-up: Each Contractor shall clean away from the job site all debris, surplus material, and similar items, resulting from his work or operations, leaving the job and equipment in a clean condition. Each Contractor shall thoroughly clean all pieces of equipment, conduit, boxes, fixtures, and similar items, leaving the installation in a first class condition.

1.24 FINAL REVIEW:

A. General: Upon completion of the Work, perform a final test of the entire system.
1. The system shall be operating properly.
2. After the final test, any changes or corrections noted as necessary for the Work to comply with these Specifications or the Drawings, shall be accomplished without delay in order to secure final acceptance of the Work.
3. The date for the final test shall be sufficiently in advance of the Contract completion date to permit execution, before expiration of the Contract, of any adjustments or alterations which the final acceptance tests indicate as necessary for the proper functioning of all equipment. Any such modifications shall be completed within the time allotted for completion of the Contract. Retests shall be conducted as directed and shall be of such time duration as necessary to ensure proper functioning of adjusted and altered items. Retests shall not relieve the Contractor of completion date responsibility.
4. Certificates, including certificates of occupancy from local authorities and documents required herein, shall be completely in order and presented to the Engineer at least one week prior to the review.
1.25 OWNER INSTRUCTION:

A. General: This Contractor and appropriate factory-trained representatives shall instruct the Owner's representative in the proper operation and maintenance of all systems and equipment and shall explain all warranties.

B. Outline: Prior to instruction of Owner Personnel, prepare a typed outline, listing the subjects that will be included in this instruction, and submit the outline for review by the Engineer.

C. Certification: At the conclusion of the instruction period obtain the signature of each person being instructed on each copy of the approved outline to signify that he has a proper understanding of the operation and maintenance of the systems and resubmit the signed outlines.

D. Other Requirements: Refer to other Division 26 Sections for additional Operator Training requirements.

1.26 CONTRACTOR WARRANTIES AND GUARANTEES:

A. General: Refer to TPWD Uniform General Conditions Article 13 for warranty requirements.

B. Equipment: All equipment bearing a manufacturer's guarantee, such as electrical equipment, devices, components, and similar items, shall be construed to have an extended guarantee to the Owner by the manufacturer. Any such equipment that proves defective in materials or workmanship within the guarantee period is to be replaced by the Contractor in accordance with the manufacturer's guarantee.

C. Start-up: The Electrical Contractor shall provide instructions and equipment starting service on new equipment for one complete year after date of final acceptance of the work by the Owner, at Contractor's sole cost and expense.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.
SECTION 260125
ELECTRICAL TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions and Supplementary General Conditions, Division 1 General Requirements, and 26 00 01 Electrical General Provisions, apply to this section.

1.2 DESCRIPTION OF WORK:
   A. General: Provide testing of electrical work installed under Divisions 26 as specified herein and in other Division 26, 27 and 28 sections. Feeders and equipment shall not be placed in service until they have been checked out and tested, as applicable.

1.3 QUALITY ASSURANCE:
   A. Personnel: Submit evidence to show that the personnel who will actually test the systems are qualified.
   B. The Engineer reserves the right to require that the originally approved personnel be replaced with other qualified personnel if, in his opinion, the original personnel are not qualified or are not properly conducting the system testing.

1.4 SUBMITTALS:
   A. Testing Procedures: Submit four copies of all proposed testing procedures to the Engineer for review at least 30 days prior to conducting any testing.
   B. Reporting Forms: Submit four copies of proposed forms to be used in recording testing data and results to the Engineer for review at least 30 days prior to conducting any testing on the project.
   C. Test Data and Results: Submit four copies of complete data and certified test results for each test performed, including, but not limited to:
      1. Test performed.
      2. Test procedure.
      3. System and area tested.
      4. Date(s) and time(s) of test.
      5. Weather conditions.
      6. Test criteria.
      7. Test results.
8. Additional pertinent information.

D. **Operational Certification:** Submit four certified copies of an operational certification which documents that all equipment and systems have been fully tested to verify proper operation in accordance with the design shown in the Construction Documents and manufacturer's recommendations.

E. **Certification:** Certifications stating that submitted test data and results are true and correct shall be provided for all submittals under this Section. Certification shall be executed by an authorized officer if the Contractor is a corporation, by a partner if the Contractor is a partnership, by the Owner if the Contractor is a sole proprietorship or by the authorized representative if the Contractor is a joint venture.

F. **Calibration List:** Submit four copies of a listing of testing devices to be used for the project to the Engineer for approval. Listing shall include documentation that devices are properly calibrated.

G. **Test Log:** The Contractor shall maintain a test log at the site to document the results of all successful and unsuccessful testing and balancing as it is performed. This log shall be available for review by the Engineer and a copy of the log shall be submitted to the Engineer prior to the Substantial Completion inspection. A space shall be provided on the test log for signoff by the OR.

1.5 **NOTICE:**

A. **General:** Notify the Engineer in writing two weeks prior all scheduled testing to allow time for Engineer to schedule witnessing of testing, where elected by the Engineer.

**PART 2 - PRODUCTS**

2.1 **TESTING MATERIALS:**

A. **General:** Provide all materials and test equipment required for testing of specified electrical systems, including retesting until acceptable test results are obtained.

B. **Products:** Tested products which fail to provide acceptable test results shall be repaired or replaced with suitable materials as required to obtain acceptable test results.

**PART 3 - EXECUTION**

3.1 **TESTING:**

A. **General:** Tests shall be made during the course of construction as specified and as required by authorities having jurisdiction. Such tests shall be conducted by this Division as a part of the Work and shall include all personnel, material, and equipment required to perform tests until satisfactory results are obtained. Any defects detected during testing shall be satisfactorily repaired or the equipment involved shall be replaced and the tests re-executed.

B. **Tests:** Testing shall include but not be limited to all items listed in other Sections of this Division and the following:
1. Thermographic Testing: Conduct a thermographic test of the main panelboards, and other electrical distribution apparatus and connections using an infrared temperature scanning unit. The test shall be performed by an independent testing laboratory (General Electric, Eaton Electrical Systems And Solutions or Siemens Industrial Service). Connections indicating higher temperature levels than are acceptable shall be tightened or corrected as required to eliminate the condition. Conduct test, using test reporting forms, at six months after installation, or before Substantial Completion, whichever comes first, but in no case beyond the one year warranty period. Correct unacceptable conditions prior to end of the warranty period.

2. Low Voltage Conductors and Cable Testing Refer to Section 26 05 19.

3. Electrical Grounding Testing Refer to Section 26 05 26.

4. Low-Voltage Lighting Control Testing Refer to Section 26 09 26.

5. Panelboards Testing Refer to Section 26 24 16.


END OF SECTION 26 01 25

E&C Engineers & Consultants Inc.
TX Firm Registration No. F-003068
SECTION 260501

ELECTRICAL BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1  RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions and Supplementary General Conditions, Division 1 General Requirements, and 26 00 01 Electrical General Provisions, apply to this section.

1.2  DESCRIPTION OF WORK:

A. Work Included: Provide basic materials and methods for electrical construction as shown, scheduled, indicated, and specified.

B. Types: The types of basic materials and methods required for the project include, but are not limited to:

1. Manner of running conduits.
2. Hangers and supports.
3. Attachment.
4. Sleeves.
5. Openings, cutting, and patching.
7. Access doors.
8. Firestopping for conduit, busway, wire, and cable.
10. Flame spread properties of materials.
11. Penetration flashing and seals.
12. Escutcheon plates.
13. Cleaning and painting of electrical work.
15. Tamper resistant fasteners.
16. Equipment housekeeping pads and anchor bolts.
17. Concrete.
18. Wiring device and equipment mounting heights.
19. [Demolition and work within existing buildings.]

1.3  SUBMITTALS:

A. Shop Drawing submittals shall include, but not be limited to, the following:

1. The Contractor shall submit to the Engineer for review, a list of proposed manufacturers and product data on hangers, supports, and methods of attachment to the structure.
2. Excavation and trenching plan, designed and sealed by a registered professional engineer. Refer to Division 1 for additional submittal requirements.
3. Cut sheets on access doors and fire stopping materials products.
4. Additional information as required in Section 260001, “Electrical General Provisions”.

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E&C No. 3420.00
1.4 PRODUCT DELIVERY, STORAGE AND HANDLING:
   A. Deliver components in factory-fabricated water resistant packaging.
   B. Handle components carefully to avoid damage to components, enclosures, and finish.
   C. Store components in a clean, dry space and protect from weather.

PART 2 - PRODUCTS

2.1 MATERIALS:
   A. **General**: Refer to PART 3 - EXECUTION of this Section and other Division 26 sections for basic electrical products and materials.

PART 3 - EXECUTION

3.1 MANNER OF RUNNING CONDUITS:
   A. All conduits shall be concealed in pipe chases, walls, furred spaces, topping, or above the ceilings of the building unless otherwise indicated.
   B. Conduit may be run exposed in mechanical rooms, duct and piping chases, but only where necessary. All exposed conduit shall be run in the neatest, most inconspicuous manner, and parallel or perpendicular to the building lines.
   C. All conduit and surface raceways shall be adequately and properly supported from the building structure by means recommended by the manufacturer, or by the use of hanger rods or clamps as herein specified.
   D. Where limited space is available above the ceilings and below concrete beams or other deep projections, conduit shall be sleeved through the projection where it crosses rather than hung below them and in a manner to provide maximum above-floor clearance.
   E. No sleeves shall be installed through any concrete beam or other deep projection without written approval of the Architect/Engineer.
   F. Run conduit to avoid proximity to heat producing equipment, piping and flues, keeping a minimum of 8” clear.
   G. Whenever possible, install horizontal conduit runs above water piping.
   H. Install all conduit to allow for adequate maintenance and access clearances to all equipment and so as to not inhibit removal of ceiling tiles.
   I. The Contractor shall study all construction documents and carefully lay out all work in advance of fabrication and erection in order to meet the requirements of limited spaces. Where conflicts occur, the Contractor shall meet with all involved trades and the Construction Inspector and resolve the conflict prior to erection of any work in the area involved.
   J. Conduit and raceway connections, rough-in and stub-up locations for equipment shall be coordinated by the Contractor to provide locations indicated on approved manufacturers equipment shop drawings. Connection, rough-in and stub-up locations shown on the Drawings are diagrammatic for general reference only.

3.2 HANGERS AND SUPPORTS:
   A. All supports required for the proper installation of equipment, cable tray, wireway, and conduit shall be provided as hereinafter specified unless otherwise indicated on the Drawings.
B. All conduits throughout the building shall be supported as specified in Section 26 05 33, “Electrical Raceways”, unless specifically noted differently on the Drawings or in the Specifications, but in every case shall be adequate to support the raceway being suspended. The supports shall be from the structure to line of grade, with proper provision for expansion, contraction, vibration elimination, and anchorage.

C. Vertical conduits shall be supported from floor lines with riser clamps sized to fit the conduit and to adequately support their weight, with allowance for expansion and contraction. At the bases of conduit, where required for proper support, provide anchor base fittings or other approved supports.

D. Perforated strap shall not be used as a hanger material. Conduit shall not be supported from ductwork, piping, or equipment.

E. All electrical conduits and surface raceways exposed to view shall be run parallel to the adjacent building construction. All hangers shall be fastened to the building structure in a manner as hereinafter specified under “Attachment”.

F. Single conduits running horizontally shall be supported by Caddy, Minerallac, or approved equal adjustable conduit hangers from adequately sized rods (minimum 1/8”) from the building structure. Refer to Section 260533 for additional requirements.

G. Multiple conduits running horizontally shall be supported by trapeze channels suspended on rods or bolted to vertical building members. Channels shall be as manufactured by Unistrut, Superstrut, Powerstrut, Kindorf, Elcen, T&B or approved equal. Conduits shall be secured to the channel with galvanized or stainless steel clamps. Refer to Section 260533 for additional requirements.

H. Vertical conduits, both concealed and exposed, shall be supported by clamping to vertical surfaces or by means of clamps resting on adjacent beams, or floor slabs, or both as required by the installation. Refer to Section 260533 for additional requirements.

I. Conduits and raceways run against building surfaces shall be supported by means recommended by the manufacturer, or by means of single or two hole rigid conduit clamps. Two-hole clamps shall be provided where size of conduit and installation conditions warrant. Refer to Section 260533 for additional requirements.

J. All auxiliary steel required for conduit, cable tray, and wireway supports, etc. shall be provided by this Division unless specifically indicated to be provided by others. All indoor support steel and fasteners shall be galvanized and all outdoor support steel and fasteners shall be hot-dip galvanized.

K. Contractor shall review all Drawings, including Structural Drawings, for details regarding supports.

L. All supports shall be of type and arrangement to prevent excessive deflection, to avoid excessive bending stresses between supports, and to eliminate transmission of vibration.

3.3 ATTACHMENT:

A. The load and spacing on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including the concrete which holds the inserts. Reinforcement at inserts shall be provided as required to develop the strength required.

B. All conduits not embedded in concrete or masonry shall be securely and independently supported so that no strain will be transmitted to outlet box and pull box supports, etc. Supports shall be rigid enough to prevent distortion of conduits during wire pulling.

C. Inserts shall be of a type which will not interfere with reinforcing, as indicated on the Structural Drawings, and which will not displace excessive amounts of structural
concrete. All methods of attachment to the structure and the use of afterset inserts shall be approved in writing by the Structural Engineer.

D. All conduit supports shall be designed and installed to avoid interference with other piping, hangers, ducts, conduit, supports, building structures, equipment, etc. All conduit, cable tray, and wireway shall be installed with due regard to expansion and contraction and the type of hanger method of support, location of support, etc. shall be governed in part by this Specification.

E. Hangers shall be attached to structure as follows:
   1. Poured-in-place Concrete:
      a. Where conduits, equipment, etc., are supported under poured-in-place concrete construction, each hanger rod shall be fitted with a nut at its upper end, which shall be set into a UL-listed universal concrete insert placed in the form work before concrete is poured.
      b. Where inserts are placed in the bottom faces of concrete joists which are too narrow to provide adequate strength of concrete to hold the insert properly, or where a larger insert would require displacement of a bottom joist steel, the hanger rod shall be suspended from the center of a horizontal angle iron, channel iron, I-beam, etc., spanning across to adjacent joists. The angle iron shall be bolted to nonadjustable concrete inserts of the "spot" type, of physical size small enough to avoid the bottom joist steel.
   2. Steel Bar Joists:
      a. Where light loads are supported under bar joists, hanger rods may be run with a washer and two nuts.
      b. Where larger loads are supported beneath bar joists, hanger rods shall be secured to angle irons of adequate size; each angle shall span across two or more joists as required to distribute the weight properly and shall be welded to the joists or otherwise permanently fixed thereto.
   3. Steel Beams: Where loads are supported under steel beams, approved type beam clamps shall be used.
   4. Wood Framing: Where loads are supported from wood framing, hanger rods shall be attached to framing with side beam brackets or angle clips.
   5. Miscellaneous Steel: All miscellaneous steel members, angles, rods, supports, and similar items specified or required for this project shall be galvanized for indoor use or hot dipped galvanized for exterior use and where exposed to ambient conditions. All required miscellaneous steel shall be provided by this Division.

F. Fastening of conduits, etc., in the building shall be as follows: To wood members - by wood screws; to masonry by threaded metal inserts, metal expansion screws, or toggle bolts, whichever is appropriate for the particular type of masonry; to steel - machine screws or welding (when specifically permitted or directed), or bolts, and to concrete by suitable inserts anchored to reinforcing steel, and poured in place unless other means are indicated on the plans. Power-actuated fasteners (shooting) will not be acceptable for attaching conduit clamps, boxes and hanger wire unless approved by the Architect/Engineer in writing.

3.4 SLEEVES:
A. Provide sleeves for timely placing in construction for all conduit passing through concrete and masonry walls, partitions, beams, floors and roofs while same is under construction.
B. In general, a conduit sleeve shall be one size larger than the size conduit which it serves, except where larger sizes are required for manufactured water stop fittings.

C. No sleeves shall be installed through any concrete beam or other deep projection without written approval of the Architect/Engineer.

D. Sleeves set in concrete floor construction shall be minimum 18 gauge, galvanized steel, and shall extend 2" above the finished floor. Where sleeve will be used to support a conduit riser clamp, sleeve gauge shall be increased accordingly.

E. Sleeves for concrete or masonry walls shall be Schedule 40, galvanized steel, and shall be set flush with the finished wall.

F. Sleeves for conduits passing through walls below grade shall be wall sleeves with corresponding segmented annular seals for the conduit size required as specified in Paragraph 3.11.

G. Where sleeves are not properly set during construction and must be installed by cutting and patching, obtain direction from the Architect/Engineer prior to proceeding.

H. Sleeves are not required where new openings are core-drilled into existing construction, unless noted otherwise on the Drawings.

3.5 OPENINGS, CUTTING AND PATCHING:

A. General: The Contractor shall be responsible for coordinating openings in the building construction for installation of electrical systems. Comply with the requirements of Division 1 for the cutting and patching of other work to accommodate the installation of electrical work. Except as individually authorized by the Architect/Engineer, cutting and patching of electrical work to accommodate the installation of other work is not permitted.

B. Cut and Patch: Cut and patch walls, floors, etc., resulting from work in existing construction or by failure to provide proper openings or recesses in new construction.

C. Methods of Cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer. Impact-type equipment shall not be used except where specifically acceptable to the Architect/Engineer. Openings in precast concrete slabs for conduits, outlet boxes, etc., shall be core drilled to exact size.

D. Approval: If holes or sleeves are not properly installed and cutting and patching becomes necessary, it shall be done at no change in Contract amount. Undertake no cutting or patching without first securing written approval from the Architect/Engineer. Patching shall create a surface which is structurally and aesthetically equal to the surface surrounding the area patched and shall be performed by the trade whose work is involved, at no change in the Contract amount.

E. Protection: Openings through exterior walls or roofs shall be provided with suitable covers while they are left open to protect the property or materials involved. Any openings through walls below grade shall be properly protected to prevent entrance of water or other damaging elements.

F. Restoration: All openings shall be restored to “as-new” condition under the appropriate Specification Section for the materials involved, and shall match remaining surrounding materials and/or finishes. Restoration work shall be performed by the trades who originally installed the work being restored and shall be performed at no cost to the Owner or Architect/Engineer.

G. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned
by the operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.

H. **Plaster:** All electrical work in areas containing plaster shall be completed prior to the application of the finish plaster coat. Cutting of finish plaster coat will not be permitted.

I. **Special Note:** No cutting, boring, or excavating which will weaken the structure shall be undertaken.

### 3.6 EXCAVATING, TRENCHING AND BACKFILLING:

A. **General:** The work hereunder includes whatever excavating and backfilling is necessary to install the electrical work. Coordinate the electrical work with other work in the same area, including excavating and backfilling, dewatering, floor protection provisions, other temporary facilities, other underground services (existing and new), landscape development, paving, structural foundations, and floor slabs on grade. Coordinate with weather conditions and provide temporary facilities needed for protection and proper performance of excavating and backfilling.

B. **Standards:** Except as otherwise indicated, comply with the applicable provisions of Division 31 for electrical work excavating and backfilling. Refer instances of uncertain applicability to the Architect/Engineer for resolution before proceeding with the Work.

C. The bottoms of trenches shall be excavated to required depths, slope and grade. The bottom of the trench shall be accurately excavated to provide firm, uniform bearing for the bottom of the raceways and ductbanks. Where mud or unstable soil is encountered in bottom of trench, it shall be removed to firm bearing and the trench shall be backfilled with bedding sand to proper grade and tamped to provide uniform firm support.

D. The bottom of trenches shall be accurately graded to provide proper fall and uniform bearing and support for each section of the conduit on undisturbed soil or 2" of sand fill at every point along its entire length. In general, grading for electrical ductbanks and conduits shall be from building to manhole, and from a high point between manholes to each manhole.

E. Exercise care not to excavate below required depth, leaving a flat bed of undisturbed earth, firm and secure, before laying cable, and ductbanks. In the event rock is encountered, excavate 6" below required depth and backfill to required depth with bedding sand, and compact to minimum 95% compaction.

F. All grading in the vicinity of excavation shall be controlled to prevent surface ground water from flowing into the excavations. Any water accumulated in the excavations shall be removed by pumping or other acceptable method. During excavation, material suitable for backfilling shall be stacked in an orderly manner a sufficient distance back from edges of trenches to avoid overloading and prevent slides or cave-ins. Material unsuitable for backfilling shall be wasted and removed from the site and properly disposed of.

G. The Contractor shall be fully responsible for the safety of persons, materials and equipment in or near trenches or other excavations and provide all required sloping, shoring, railings and other protective provisions. The Contractor shall provide a trench shoring plan and design which is sealed by a registered professional engineer. Refer to Divisions 1 and 2 for additional requirements.

H. If any unknown and/or uncharted utilities are encountered during excavation, promptly notify Architect/Engineer and wait for his instructions before proceeding.

I. If such unknown utilities are encountered and work is continued without contacting the Architect/Engineer for instructions, and damage is caused to said utilities, the Contractor
shall repair at his own expense, such damage to the satisfaction of the owner or utility company concerned.

J. Trenches shall not be backfilled until all required tests have been made by the Contractor and approved by the Architect/Engineer and any local authorities having jurisdiction.

K. Backfill shall be compacted or cement stabilized sand up to 6” above the top of conduit or ductbank. Backfill up to grade shall be in maximum 6” lifts with minimum 95% compaction of lifts. Refer to Division 31 or elsewhere in Contract Documents for additional trenching and backfill requirements.

L. Opening and Reclosing Pavement, Landscape Areas and Lawns: Where excavation requires the opening of existing walks, street, drives, other existing pavement or lawns, such surfaces shall be cut as required to install new conduit and to make new connections to existing conduits. The sizes of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new work is completed and the excavation has been backfilled and flooded, the area shall be patched or replaced, using materials to match those cut out or removed. Patches shall thoroughly bond with the original surfaces, shall be level with them, and shall meet all the requirements established by the authorities having jurisdiction over such areas. All removed work shall be replaced by craftsman who regularly install the types of work being replaced.

M. Excavation in Vicinity of Trees: All trees including low hanging limbs within the immediate area of construction shall be adequately protected to a height of at least 5’ to prevent damage from the construction operations and/or equipment. All excavation within the outermost limb radius of all trees shall be accomplished with extreme care. All roots located within this outermost limb radius shall be brought to the attention of the Architect before they are cut or damaged in any way. The Architect will give immediate instructions for the disposition of same. All stumps and roots encountered in the excavation, which are not within the outermost limb radius of existing trees, shall be cut back to a distance of not less than 18” from the outside of any concrete structure or pipeline. No chips, parts of stumps, or loose rock shall be left in the excavation. Where stumps and roots have been cut out of the excavation, clean compacted dry bank sand shall be backfilled and tamped.

3.7 ACCESS DOORS:

A. General: This Contractor shall provide wall or ceiling access doors for installation in finished surfaces for unrestricted access to all concealed items of electrical equipment.

B. Types: Doors shall be factory-finished as noted below and turned over to the General Contractor for installation. Refer to finish painting requirements specified herein below. Doors shall be as manufactured by Inryco/Milcor or an approved equal in the following styles:

1. Drywall Construction Inryco/Milcor Style DW with gray prime finish.
2. Finished Acoustical Ceiling Tile Inryco/Milcor Style AT with door designed for tile insert.
3. Finished Plaster Ceiling or Walls Inryco/Milcor Style WB-PL with door designed for finish plastering.
4. Masonry Walls Inryco/Milcor Style M with gray prime finish.
5. Fire Rated Construction Inryco/Milcor Fire Rated Access Door with gray prime finish.
6. Fire Rated Ceiling or Ceiling Assembly: Inryco/Milcor Style ATR with door designed for tile insert.

C. Selection: Access doors shall be furnished with a continuous piano hinge with screwdriver-operated flush locks and shall be a minimum of 12” x 12”. Larger sizes shall be furnished where required for proper access. Access doors shall not be installed until location and style has been approved by the Architect.

D. Approval: Access door shall not be installed until location and style have been approved by the Architect.

3.8 FIRESTOPPING FOR CONDUIT, BUSWAY, WIRE AND CABLE:

A. General: Provide a UL Systems Classified, intumescent material capable of expanding up to three to five times when exposed to temperatures beginning at 250°F for sealing all holes or voids created to extend electrical system conduit, raceways, busway, wire, cable and other components through fire-rated floors and walls to prevent the spread of smoke, fire, toxic gas and water.

B. Fire barrier products shall be used to create through-penetration firestop systems as required. All firestop systems shall be listed in the Underwriter's Laboratories Building Materials Directory, Through Penetration Firestop Systems (XHEZ).

C. The products manufactured by 3M/Electrical Products Division or an approved equal are acceptable subject to Shop Drawing submittal approval.

D. Install firestop materials according to the following UL Systems Classifications and manufacturer's recommendations:

<table>
<thead>
<tr>
<th>OPENING TYPE</th>
<th>UL SYSTEM CLASSIFICATION NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal Conduit/Metal Pipe Through Round Openings</td>
<td>No. 49, No. 95, No. 147.</td>
</tr>
<tr>
<td>Busway Through Rectangular Openings</td>
<td>No. 99.</td>
</tr>
<tr>
<td>Insulated Power Cables/Telephone Cables Through Openings</td>
<td>No. 33, No. 49, No. 149.</td>
</tr>
<tr>
<td>Blank Openings/Joints/Expansion Trenches</td>
<td>No. 92, No. 102, No. 61.</td>
</tr>
<tr>
<td>Cable Tray (Single or Double)</td>
<td>No. 105.</td>
</tr>
<tr>
<td>Metal Pipe/Conduit/Cables Through Large Openings</td>
<td>No. 93.</td>
</tr>
<tr>
<td>Plastic Pipe/Plastic Conduit Through Openings</td>
<td>No. 64b, No. 148.</td>
</tr>
<tr>
<td>All Other Firestop Systems</td>
<td>Per manufacturer's recommendations.</td>
</tr>
</tbody>
</table>

E. Provide fire rated insulation blankets around conduits where shown on Drawings. Blankets shall be one inch (1”), 8 pound density thermo ceramic material, Thermo Ceramics Kas-Wool Fire Master Series thermal blankets or and approved equal. Blankets shall be wrapped to provide continuous coverage and be secured with stainless steel bands in accordance with the manufacturer's UL-listed installation instructions.

3.9 FIRE-RATED PARTITIONS:

A. Coordinate locations of raceways in fire-rated partitions so not to effect the fire rating of the partition. Notify the Architect/Engineer in writing where additional construction is required to maintain the partition fire rating.
B. Outlet boxes installed in fire-rated partitions (2 hour or less) shall not exceed 16 square inches, with a maximum of 100 square inches of wall opening per 100 square feet of wall area.

C. The outlet boxes shall be located whereby no two outlet boxes are installed closer than 24" on center, and securely attached to the partition studs, with at least one partition stud separating the outlet boxes.

3.10 FLAMESPREAD PROPERTIES OF MATERIALS:
A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255 (1984), "Method of Test of Surface Burning Characteristics of Building Materials". The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke-developed rating of 50.

3.11 PENETRATION FLASHING AND SEALS:
A. Conduit sleeves, pitch pockets, and flashings compatible with the roofing and waterproofing installation shall be provided for all roof and wall penetrations and roof-mounted equipment and supports. Coordinate flashing details with the Architectural details and the roofing/waterproofing contractors.

B. Conduits passing through walls where exposed to weather or below grade shall pass through waterstop sleeves (new construction) or core-drilled openings (existing construction). The space between the conduit and sleeve/opening shall be sealed using segmented annular seals to prevent the entry of water or foreign materials. Segmented annular seals shall be Thunderline Incorporated, Type LS Series, Style C insulating type link seals for temperatures up to 250°F, or an approved equal. Waterstop sleeves shall be Thunderline Corporation Century-Line or equal noncorroding thermoplastic sleeves with a molded in water stop lip.

3.12 ESCUTCHEON PLATES:
A. Except as otherwise noted, provide chrome-plated brass floor and ceiling escutcheon plates around all pipes, conduits, etc., passing exposed through walls, floors, or ceilings, in any finished spaces except under floor and attic spaces. Plates shall be sized to fit snugly against the outside of the conduit. Plates will not be required for conduit where pipe sleeves extend above finished floor. All equipment rooms are classified as finished spaces.

3.13 PROHIBITED MARKINGS:
A. Prohibited Markings: Markings which are intended to identify the manufacturer, vendor, or other source from which the material has been obtained are prohibited for installation within public, tenant, or common areas within the project. Also prohibited are materials or devices which bear evidence that markings or insignias have been removed. Certification, testing (example, Underwriters’ Laboratories, Inc.), and approval labels are exceptions to this requirement.

3.14 TAMPER RESISTANT FASTENERS:
A. All exposed fasteners utilized shall be of a tamper resistant design. All fasteners shall be of the same type whenever possible. Coordinate fastener selection with other trades to provide similar fastener types whenever possible. A minimum of three tools for use with
each type of tamper resistant fastener shall be furnished to the Owner at the time of substantial completion.

3.15 EQUIPMENT HOUSEKEEPING PADS AND ANCHOR BOLTS:

A. Concrete pads for equipment (Housekeeping Pads) will be furnished under this Division. Pads shall be provided in locations where floor mounted equipment is to be installed.

B. Pads shall be nominal 4” high and shall extend a minimum of 3” beyond all equipment and supports while generally conforming to the shape of the equipment.

C. Pads shall be minimum 2500 psi (28 day) concrete reinforced with No. 6 - 6” x 6” welded wire mesh. Pad tops and sides shall be hard troweled smooth with a 3/4” bull nose on all external corners. Refer to Division 3 for additional requirements.

D. Furnish galvanized anchor bolts with layout templates for installation in equipment pads. Bolts shall be of the size and quantity recommended by the manufacturer and where vibration isolators are used, they shall be anchor bolted to the equipment pad.

3.16 CONCRETE:

A. All concrete used in light pole bases and ductbank encasement shall be 5 sack mix with 1/2” maximum aggregate and 3000 psi compressive strength when tested after 28 days in accordance with ASTM 039-44, “Standard Method of Test for Compressive Strength of Concrete”. Refer to other Divisions for additional requirements.

B. Add 8 pounds of L. Sonneborn Sons, Inc. “Sonobrite Red” or and approved equal dye per cubic yard of wet mix ductbank encasement concrete to form a uniform red color throughout the concrete.

C. Use forms except where the earth is firm enough to support the concrete. Above grade portions of pole bases shall be formed using Sonatube or an approved equal forming system.

D. Keep concrete wet at least 48 hours after forms are removed to ensure proper curing.

E. Ductbanks and light pole bases shall be reinforced where noted on the Drawings. Refer to Division 3 for reinforcing steel.

F. Ductbank concrete shall be carefully spaded during the pouring to eliminate all voids under and between the ducts and to prevent honeycombing of the exterior surfaces. Power driven tampers or agitators shall not be used unless specifically designed for the application.

G. Generally, each run of the ductbank shall be poured in one continuous operation. Where more than one pour is necessary, each pour shall terminate in an angular plane, and reinforcing rod dowels shall be added as necessary to ensure a sound joint. Partial pours shall not terminate in horizontal or vertical planes.

H. The concrete encasement covering the ductbank may be poured directly against the sides of the trenches if the cut is clean enough, and free of loose material. All loose dirt and extraneous material shall be removed from the trenches before and during the pouring of the concrete to ensure sound envelopes. The trench bed shall be smooth and properly graded for the placement of the bottom row of spacers.

3.17 WIRING DEVICE AND EQUIPMENT MOUNTING HEIGHTS:

A. Refer to architectural drawings to determine whether outlets occur in wainscot or cabinet spaces and coordinate mounting heights as required by architectural form. For example, mounting heights of outlets occurring in a tile or brick wall should be adjusted so that the
outlet will occur entirely within a single course. However, all outlets in a given space shall be mounted at the same height.

B. In general, **unless noted otherwise on Architectural or Electrical Drawings**, mounting heights to device center line shall be as follows [outlets occurring in tile walls shall be shifted, slightly, to allow mounting at the best suitable point in a particular tile]:

1. **Wall Switches** 45” above finished floor.
2. **Receptacles** 18” above finished floor.
3. **Receptacles**
   - 6” above countertops without splashbacks
   - 4” above splash backs for countertops with splash backs, mounted with their long axis horizontal.
4. **Clock Outlets** 7’-6” above finished floor.
5. **Panelboards** 72” from finish floor to top of panelboard.
6. **Stairway Lighting Fixtures** Wall mounted 7’-6” above finished floor or mid-landing.
7. **Fire Alarm Pull Stations** 45” above finished floor.
   - Coordinate with architectural graphics package for actual mounting heights.
8. **Fire Alarm Wall-Mounted**
   - 6’8” above finish floor or 6” below ceiling, Audio/Visual Signals whichever is lower.
9. **Voice and Data Processing Outlets** 18” above finished floor.
10. **Wall Telephone Outlets** 45” above finished floor.

C. All receptacles shall be mounted with their long axis **vertical**, unless noted otherwise.

### 3.18 DEMOLITION AND WORK WITHIN EXISTING BUILDINGS:

A. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and in service maintenance of all electrical services for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.

B. The Contractor shall provide temporary or new services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.

C. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, conduit, outlet boxes, wiring, light fixtures, equipment, and similar items, to provide this access and shall reinstall same upon completion of work in the areas affected.

D. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed and reinstalled, this Contractor shall remove and reinstall, in locations approved by the Architect, all devices required for the operation of the various systems installed in the existing construction.

E. Outages of services as required by the new installation will be permitted but only at a time approved by the Owner. The Contractor shall allow the Owner 2 weeks in order to schedule required outages. The time allowed for outages will not be during normal
working hours unless otherwise approved by the Owner. All costs of outages, including overtime charges, shall be included in the contract amount.

F. The Contractor shall modify, remove, and/or relocate all materials and items so indicated on the Drawings or required by the installation of new facilities. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage. Survey the project with the Owners representative before demolition begins and determine all materials which the Owner specifically chooses to have salvaged. Pre-establish with the Owner locations where salvaged materials are to be stored. Salvage materials shall remain the property of the Owner, and shall be delivered to such destination as directed by the Owner. Materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations shall be repaired and restored to good operative condition. The Contractor may, at his discretion and upon the approval of the Owner, substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.

G. All items which are to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore to good operative order. All relocations shall be performed by workmen skilled in the work and in accordance with standard practice of the trades involved.

H. When items scheduled for relocation are found to be in damaged condition before work has been started on dismantling, the Contractor shall call the attention of the Owner to such items and receive further instructions before removal. Items damaged in repositioning operations are the Contractor's responsibility and shall be repaired or replaced by the Contractor as approved by the Owner, at no additional cost to the Owner.

I. Service lines and wiring to items to be removed, salvaged, or relocated shall be removed to points indicated on the Drawings, specified, or acceptable to the Owner. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied-off or disconnected in a safe manner acceptable to the Owner. All disconnections or connections into the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Services to existing areas or facilities which must remain in operation during the construction period shall not be interrupted without prior specific approval of the Owner as hereinbefore specified.

J. During the construction and remodeling, portions of the project shall remain in service. Construction equipment, materials, tools, extension cords, etc., shall be arranged so as to present minimum hazard or interruption to the occupants of the building.

K. Certain work during the demolition and alteration phases of construction may require overtime or nighttime shifts or temporary evacuation of the occupants. Coordinate and schedule all proposed down time with the Owner's Representative at least 72 hours in advance.

L. Make every effort to minimize damage to the existing building and the Owner's property. Repair, patch, or replace as required any damaged which might occur as a result of work at the site. Care shall be taken to minimize interference with the Owner's activities during construction. Cooperate with the Owner and other trades in scheduling and performance of the work.

M. Include in the contract price all rerouting of existing conduits, wiring, outlet boxes, fixtures, etc., and the reconnecting of existing fixtures as necessitated by field conditions to allow the installation of the new systems. Furnish all temporary conduit, wiring boxes,
etc., as required to maintain lighting and power service for the existing areas with a minimum of interruption.

N. All existing lighting fixtures, switches, outlets, speakers, materials, equipment and appurtenances not included in the remodel or alteration areas are to remain in place and shall remain in service.

O. Electrical equipment, outlets, speakers, circuits to mechanical and building systems equipment, etc., which are to remain but which are served by conduit and/or circuiting that is disturbed by the remodeling work, shall be reconnected in such a manner as to leave it in proper operating condition.

P. Existing branch circuit wiring which is to be removed, shall be pulled from the raceways and the empty conduit shall be removed to a point of permanent concealment.

Q. Existing lighting fixtures shown to be removed and indicated to be reused, shall be cleaned, repaired, relamped and provided with such new accessories as may be needed for the proper installation in their new locations.

R. New circuiting indicated to be connected to existing panels shall be connected to "spares" and/or "released" breakers as applicable, or new breakers provided where space is available. Contractor shall verify the existing panel load and feeder capacity prior to adding any additional loads.

S. Within the remodeled or alteration areas where existing ceilings are being removed and new ceilings are installed, all existing lighting fixtures, other ceiling mounted devices and their appurtenances shall be removed and reinstalled into the new ceiling, unless otherwise shown or specified.

T. Within the remodeled or alteration areas where existing walls are being removed, all existing lighting fixtures, switches, receptacles, other materials and equipment and their appurtenances shall be removed, where required by the remodel work either shown or specified.

U. Any salvageable equipment as determined by the Owner, shall be delivered to the Owner, and placed in storage at the location of his choice. All other debris shall be removed from the site immediately.

V. No portion of the fire alarm system shall be turned off, modified or changed in any way without the express knowledge and written permission of the Owner's Representative.

W. Refer to Architectural "Demolition" and "Alteration" plans for actual location of walls, ceilings, etc. being removed and/or remodeled.

END OF SECTION 260501
SECTION 260519

LOW VOLTAGE CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions and Supplementary General Conditions, Division 1 General Requirements, and 26 00 01 Electrical General Provisions, apply to this section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide low voltage electrical conductor, cable, wire, and connector work as shown, scheduled, indicated, and as specified.

B. Types: The types of low voltage electrical conductor, cables, wire, and connectors required for the project include, but are not limited to, the following:
   1. 600 volt building wire and cable.
   2. 600 volt building wire and cable connectors.
   3. 300 volt control/signal wire and cable.
   4. 300 volt control/signal wire and cable connectors.

C. Application: The applications for cable, wire, and connectors required on the project are as follows:
   1. Power distribution circuitry.
   2. Lighting branch circuitry.
   3. Appliance, receptacle and equipment branch circuitry.
   5. Control wiring.

1.3 STANDARDS:

A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:
   1. ANSI/ICEA S-95-658/NEMA WC70 – Nonshielded 0-2kV Cables

B. Where application of applicable codes, Trade Association standards, or publications appears to be in conflict with the requirements of this Section, an interpretation shall be obtained from the Architect/Engineer.

1.4 QUALITY ASSURANCE:

A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
   1. 600 Volt Building Wire and Cable:
      a. Alcon. (aluminum)
      b. Cerro Wire and Cable Company.
      c. Colonial Wire and Cable.
d. Encore Wire Corporation.
e. General Cable Corporation.
f. Okonite Company.
g. Republic Wire Inc.
h. Southwire Company.
i. United Copper Industries.

2. Type MC Cable:
   a. AFC.
   b. Southwire.
   c. United Copper Industries.

3. 300 Volt Wire and Cable:
   a. Alpha.
   b. Belden.
   c. West Penn.

4. Connectors:
   a. AMP, Inc.
   b. Buchanan.
   c. Burndy Corporation.
   d. O. Z. Gedney Company.
   e. General Electric Company.
   f. Ideal Industries, Inc.
   g. Mac Products, Inc.
   h. Minnesota Mining and Manufacturing Company (3M).
   i. Penn-Union.
   j. Thomas & Betts Company.

B. UL Label: All cable, wire, and connectors shall be UL-labeled.

1.5 SUBMITTALS:
A. Shop Drawing submittals shall include, but not be limited to, the following:
   1. The Contractor shall submit to the Engineer for review, a list of the proposed
      manufacturers of wire and cable, cable lugs, cable connectors and termination fittings
      listed herein. The Contractor may install wire and cable, cable lugs, cable connectors
      and termination fittings furnished by any manufacturer listed on the approved
      submittal.
   2. Cut sheets on all 300 and 600 volt conductors with manufacturers name, ratings and
      capacities, insulation characteristics, and available colors, clearly listed.
   3. Cut sheets indicating all cable lugs, termination fittings and cable connectors.
   5. Information on aluminum wire and cable, conductor and conduit sizing and
      compression lugs, if the aluminum option is taken.
   6. Additional information as required in Section 260001, “Electrical General Provisions”.

1.6 DELIVERY, STORAGE AND HANDLING:
A. Provide factory-wrapped waterproof flexible barrier material for covering wire and cable wood
   reels, where applicable; and weather resistant fiberboard containers for factory-packaging of
   cable, wire and connectors, to protect against physical damage in transit. Damaged cable,
   wire, or connectors shall be removed from project site.
B. Store cable, wire, and connectors in their factory-furnished coverings, and in a clean, dry indoor space which provides protection against the weather.

PART 2 - PRODUCTS

2.1 600 VOLT BUILDING CABLE, WIRE AND CONNECTORS:

A. General: Except as otherwise indicated, provide cable, wire, and connectors of manufacturer's standard materials, as indicated by his published product information, designed and constructed as instructed by the manufacturer, and as required for the installation.

B. Wire and Cable: Provide factory-fabricated wire and cable of the size, rating, material, and type as indicated for each service. Where not indicated, provide proper selection as required to comply with installation requirements and with NEC standards. The minimum size wire to be used for power or lighting circuits shall be No. 12 copper (No. 14 for light fixture pigtails) with insulation as noted below. Minimum size for control wiring shall be No. 14 copper.

C. Conductors: Provide soft or annealed copper wires meeting, before stranding, the requirements of ASTM B3, "Standard Specification for Soft or Annealed Copper Wire for Electrical Purposes", latest edition.

1. Conductors for power wiring sized No. 10 AWG and smaller shall solid.
2. Conductors sized No. 8 AWG and larger shall be stranded. Stranding shall be Class B meeting the requirements of ASTM B8, "Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, or Soft".

D. Insulation: Insulation shall meet or exceed the requirements of UL 83, "Standard for Thermoplastic Insulated Wires".

1. Insulation for conductors sized No. 10 AWG and smaller shall be UL Type "THHN/THWN" (rated at 90°C in dry locations and 75°C in wet locations).
2. Insulation for conductors sized No. 8 AWG and larger shall be UL Type "THHN/THWN" (rated at 90°C in dry locations and 75°C in wet locations).
3. Insulation for conductors sized No. 8 AWG and larger shall be UL Type "RHH" for 2 hour fire rated cable (rated at 90°C in dry locations).
4. All wiring inside lighting fixtures shall be temperature rated per the NEC.
5. Branch circuit wiring within 3" of fluorescent ballasts shall be temperature rated for 90°C.
6. In the ceiling areas of equipment rooms where the temperature may exceed 102°F under operating conditions, higher temperature insulation shall be used on conductors. Acceptable types are "RHH", "THHN", and "XHHW".

E. Connectors for Building Wire and Cable: Provide factory-fabricated, metal connectors of the size, rating, material, type, and class required for each use.

2.2 TYPE MC CABLE:

A. Metal-clad Type MC Cable: At the Contractor's option, and subject to the approval of the local electrical inspection department and where allowed in the NEC, Type MC cable may be used for receptacle circuits, switch legs, and lighting fixture connections to the junction box grid system in finished areas. Type MC cable shall consist of two No. 12 AWG copper THHN insulated phase conductors and one No. 12 AWG green THHN insulated copper ground conductor, all enclosed in cable tape and an aluminum or galvanized steel flexible armor. Type MC cable terminations shall be made using approved anti-short fittings. Refer to NEC 517 where use is approved by the NEC for emergency wiring.
2.3 300 VOLT CONTROL/SIGNAL CABLE, WIRE AND CONNECTORS:

A. **General:** Except as otherwise indicated, provide cable, wire, and connectors of manufacturer's standard materials, as indicated by his published product information, designed and constructed as instructed by the manufacturer, and as required for the installation.

B. **Wire and Cable:** Provide factory-fabricated wire and cable of the size, rating, material, and type as indicated for each use.

C. **Conductors:** Provide soft or annealed copper wires as individual conductors, twisted together or shielded, where required, and meeting, before stranding, the requirements of ASTM B3, "Standard Specification for Soft or Annealed Copper Wire for Electrical Purposes", latest edition.

D. **Conductor Gauge:** Provide conductor gauge as required for the application with a minimum of 24 AWG. Conductors shall be stranded or solid as required by the application or manufacturer.

E. **Insulation:** Insulation shall meet or exceed the requirements of UL 83, "Standard for Thermoplastic Insulated Wires", and the requirements of NEC Article 725 for Class 2 wiring.
   1. Insulation shall be rated for a maximum working voltage of 300 volts; PVC jacket; UL-listed.
   2. Insulation of cables used in environmental air spaces shall be nonmetallic jacket UL-listed for use in air plenums.

F. **Connectors:** Provide factory-fabricated, metal connectors of the size, rating, material, type, and class required for the application.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. **General:** Install electrical cable, wire and connectors as shown, in accordance with the manufacturer's written instructions, the applicable requirements of NEC, the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended functions.

B. **Coordination:**
   1. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.
   2. Installer shall examine the areas and conditions under which cable, wire and connectors are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Inspect wire and cable for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

C. 600 Volt Building Wire and Cable:
   1. Mains and feeders are to be run their entire length in continuous pieces without joints or splices.
   2. All interior and exterior wire shall be run in conduit. Direct buried cable shall be allowed.
   3. Conductors may be run in multiple on sizes No. 1/0 AWG through 600 kcmil inclusive, provided all multiple conductors are the same size, length, and type of insulation, and
are so arranged and terminated as to ensure equal division of the total current between all conductors involved.

4. Before any wire is pulled into any conduit, the conduit shall be thoroughly swabbed in such a manner as to remove all foreign material and to permit the wire itself to be pulled into a clean, dry conduit. All conductors shall be pulled into the conduit at the same time.

5. Cables shall be selected on the basis of their purpose and UL-listing. Generally, use Types "THWN" and "THHN" in building interiors and other dry locations. Outdoors and underground in raceways, use Type "THWN". Conductors subject to abrasion, such as in lighting poles, shall be Type "THWN" or "THHN".

6. Feeder conductors shall be sized such that the voltage drop from the source to the load served shall not exceed 2% at maximum load and 80% power factor, at 120/208 volts and 1% at maximum load and 80% power factor at 277/480 volts.

7. Where pulling lubricant is required, use only non-wax based cable lubricants equal to American Polywater as a lubricant. Wire pulling lubricant shall not be used when installing branch circuit conductors from panelboards with "isolation" transformers.

8. Pull all conductors together when more than one conductor is being installed in a raceway. Where more than six power conductors are installed in a single conduit, a conductor derating factor per NEC Table 310-15(B)(2)(a) shall be applied to conductor ampacity.

9. The use of shared branch circuit neutrals is not permitted. Separate neutral conductors shall be pulled for all branch circuits served by single pole and where required for 2 and 3 pole circuit breakers.

10. No conductor smaller than No. 12 AWG shall be used for power or lighting purposes (except light fixture tails). Switch legs shall be No. 12 AWG. Control circuit wiring may be No. 14 AWG minimum, and shall not be run in same conduit with power wiring.

11. Lighting and power branch circuit conductors shall be sized such that the voltage drop from the panelboards to the farthest point on the circuits shall not exceed 2% at maximum load and 80% power factor, at 120/208 volts and 1% at maximum load and 80% power factor at 277/480 volts.

12. For 120 volt, 20 amp branch circuits with a length of 75’ or more to the homerun junction box or first outlet, provide minimum No. 10 AWG conductors to the homerun junction box or first outlet. Where the additional circuit length from the homerun junction box or first outlet to the last outlet exceeds 75’, provide minimum No. 10 AWG conductors to the last outlet.

13. For 208 volt, 20 amp branch circuits with a length of 100’ or more, provide minimum No. 10 AWG conductors for the entire branch circuit.

14. For 208 volt, 30 amp branch circuits with a length of 100’ or more, provide minimum No. 8 AWG conductors for the entire branch circuit.

15. For 277 volt, 20 amp branch circuits with a length of 150’ or more, to the first outlet provide minimum No. 10 AWG conductors to the center of the load (minimum first outlet, where there is only one outlet).

16. Lighting fixtures shall not be used for raceways for circuits other than parallel wiring of fixtures.

17. Conductors for connection to individual light fixtures in grid type ceilings from their associated junction boxes, shall be 3 No. 14 AWG THHN copper 600 volt, solid conductors in 72” long 3/8” flexible metal conduit fixture-tails, or by Type MC cable fixture tails where permitted by the local authority having jurisdiction, in lengths not to exceed 8’.

18. All conductors in vertical conduits or raceways shall be supported in the manner set forth in the latest edition of the National Electrical Code.
19. 2 hour rated cables shall be installed in conduit and supported per UL to provide a 2 hour installed rating.
20. Do not use a pulling means, including fish tape, cable, or rope which can damage the raceway.
21. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
22. Install exposed wire and cable, parallel and perpendicular to surface or exposed structural members and follow the surface contours, where possible.
23. All wire on this project shall be new, unused, in good condition, and shall be delivered in standard coils, package, or rolls. Samples of all wire shall be submitted by the Contractor when requested by the Engineer for the purpose of determining acceptability of the wire.
24. Wire which has been rejected by the Engineer shall not be used again. Decisions as to the quality of the wire furnished and the acceptance of such wire shall be made by the Owner's duly authorized representative.
25. Do not permit conductors entering or leaving a junction or pull box to deflect so as to cause pressure on the conductor insulation.
26. Splices and taps on branch circuits shall occur only when such circuits divide as shown on the drawings and shall consist of one "through" circuit to which the circuit shall be spliced or tapped. Through wiring of receptacles and other devices is not allowed, except for GFI devices noted on the drawings to protect downstream devices.
27. Connections to devices (receptacles, switches, etc.) shall be made with individual conductors. The devices shall not be used for "feed-thru" purposes. Where "feed-thru" conditions exist, use "pig-tail" splices as described above. Color coding of "pig-tail" splices shall conform to Section 260553, "Identification for Electrical Systems".
28. No splices or taps shall be made in any conductor except in outlet boxes, junction boxes, splice boxes, or other devices and equipment in exposed and accessible locations approved for the purpose by the latest edition of the NEC.
29. All wire connections or splices on conductors No. 18 AWG through No. 8 AWG shall be made with pre-insulated spring type connectors. No other type of mechanical connector shall be used for No. 8 AWG and smaller conductors.
30. All No. 6 AWG and larger copper conductors terminated on the "load" side lugs of all switchboard circuit devices, and the "line" and "load" side lugs of all other devices shall be terminated with set-screw type pressure connectors approved for the purpose.
31. All No. 6 AWG and larger copper conductors which are to be spliced or tapped in wireways, gutters, or junction boxes shall be spliced or tapped using hydraulically applied, high conductivity compression connectors, or with set-screw type pressure connectors approved for the purpose, using 3-M electrical tape or manufactured connector covers approved for the purpose.
32. The manufacturer's recommended installing tool shall be used for the installation of all hydraulically applied compression type lugs or connectors.
33. Support cables above accessible ceilings; do not rest on ceiling tiles. Use spring metal clips or plastic cable ties to support cables from structure. Include bridle rings or drive rings.
34. Multiple circuit wires in bundles or harnesses terminating in control panels, switchboards, panelboards, etc., shall be loosely bundled, trained, and laced to achieve a neat and workmanlike appearance.
35. Surplus wire shall be trimmed to proper length. Do not fold and stuff surplus wires into wiring gutters.
36. Wires exiting harness shall be trained at 90 degree angles to termination point.
37. Refer to Section 250553, “Identifications for Electrical Systems” for color coding and identification of conductors.

D. Type MC Cable:
   1. Type MC cable may be used, where approved by the local authority having jurisdiction and allowed in the NEC: for drops in partitions to receptacles; for single circuit branch circuit wiring to individual receptacles; for lay-in fixture pigtails (10’ maximum length); for switch leg drops; from fixture junction boxes to nonlay-in fixtures; or for single circuit branch circuit wiring from fixture to fixture (except lay-in fixtures) and fixture to junction box.
   2. Type MC cable shall not be used for branch circuit homeruns. Type MC cable shall not be used for receptacle to receptacle wiring in partitions; where more than three conductors (phase/neutral/ground) are required; where exposed; or in lengths exceeding 20’.
   3. Type MC cable in partitions shall be protected in accordance with the requirements of the NEC.
   4. Type MC cable shall be supported as specified herein and in accordance with the NEC.
   5. Refer to the Drawings for additional requirements concerning the use of Type MC cable.
   6. Type MC cable may only be used in concealed locations.

E. 300 Volt Control/Signal Cable and Wire:
   1. Install all low voltage wiring in a suitable raceway except in areas with accessible (lay-in) ceilings unless otherwise noted on Drawings or other Division 26 sections. Where cable is routed without a raceway, bundle all cables and suspend to one foot above ceiling using loop rings on 5’ centers. Do not run cable loose on top of suspended ceilings. Do not attach cables to suspended ceiling supports or any mechanical, plumbing, or sprinkler piping. Conceal conduit except in mechanical rooms and areas where other conduit and piping are exposed. Fasten flexible conductors, which bridge cabinets and doors, neatly along hinge side and protect against abrasion. Tie and support the conductors neatly.
   2. Remote control wires shall be no smaller than No. 14 AWG. Control wires shall be run in separate conduits. Departures from the sizes so determined shall be made only in those cases in which the National Electrical Code required the use of larger conductors. The sizes as determined from these tables shall be regarded as the acceptable minimum under all other circumstances. In no case, however, shall there be a voltage drop greater than that specified in any feeder or branch circuit. This voltage drop shall be based on the full load, 70% power factor, the total impedance drop of 60 Hz alternating current and with the reactance drop in the respective metal conduits duly considered. The Contractor may, if he deems it necessary or advisable, use larger sized conductors than those shown. Under no circumstances, however, shall the Contractor use any conductors sized in a manner which does not conform to the above mentioned tables without having first secured the written approval of the Owner’s duly authorized representative.
   3. Number code or color code conductors appropriately for future identification and servicing of the system. Refer to Section 260553, “Identification for Electrical Systems”, for additional requirements.
   4. Make all splices and connections in stranded conductors using UL-approved solderless crimp connectors.

3.2 TESTING:
A. **Feeder Insulation Resistance Test:** Each new 600 volt feeder conductor shall have its insulation resistance tested after the installation is complete except for connection at its source and point of termination.

1. Tests shall be made using a Biddle Megger or equivalent test instrument at a voltage of not less than 1000 volt dc. Resistance shall be measured between phase, neutral, and ground conductors and from conductors to raceway (ground). Readings shall be taken after 30 seconds and 60 seconds of Megger operation at slip speed and insulation resistance shall not be less than the following:

<table>
<thead>
<tr>
<th>Wire Size (AWG)</th>
<th>Resistance (Ohms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 12</td>
<td>1,000 K</td>
</tr>
<tr>
<td>No. 10 through No. 8</td>
<td>250 K</td>
</tr>
<tr>
<td>No. 6 through No. 2</td>
<td>100 K</td>
</tr>
<tr>
<td>No. 1 through No. 4/0</td>
<td>50 K</td>
</tr>
<tr>
<td>Larger than No. 4/0</td>
<td>25 K</td>
</tr>
</tbody>
</table>

2. New conductors which do not meet or exceed the insulation resistance values listed above shall be removed, replaced, and retested.

B. **Neutral Testing:** After all feeder and branch circuit conductors are terminated, neutral to ground testing shall comply with the following:

1. The resistance of the system's neutral to ground shall be greater than 10 Kohms with the system bonding jumper disconnected.

2. Repeat neutral to ground test for neutrals of separately derived systems.

C. **Pre-energization Check:** Prior to energization, check all new branch circuit cable and wire for continuity of circuitry and for short circuits. Correct malfunction when detected. No submittal is required for this test.

D. **Voltage and Current Values:** The voltage and current in each main feeder conductor shall be measured and recorded after all connections have been made and the feeder is under load.

E. **Submittals:** Contractor shall furnish all instruments and personnel required for tests. Submit four copies of certified test results to Architect for review. Test reports shall include conductor tested, date and time of test, test results, relative humidity, temperature, and weather conditions. Refer to Section 260125, "Electrical Testing", for additional requirements.

### 3.3 PROJECT RECORD DOCUMENTS:

A. Refer to TPWD Division 1 General Requirements for requirements related to “as-constructed drawings” or Record Documents.

### 3.4 IDENTIFICATION:

A. **Identification:** Refer to Section 260553, “Identification for Electrical Systems”, for color-coding and markings for all conductors and cables.

END OF SECTION 260519
SECTION 260526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General
Conditions and Supplementary General Conditions, Division 1 General Requirements,
and 26 00 01 Electrical General Provisions, apply to this section.

1.2 DESCRIPTION OF WORK:
A. Work Included: Provide electrical service, distribution, and equipment grounding as shown,
scheduled, indicated, and as specified.
B. Types: The types of electrical service and equipment grounding specified in this Section
include, but are not necessarily limited to, grounding all equipment and devices shown and as
required by the National Electrical Code (NEC), the local electrical inspection department, and
The Power Company.

1.3 STANDARDS:
A. Products shall be designed, manufactured, tested, and installed in compliance with the
following Standards:
   1. ANSI/IEEE Standard 142 - Recommended Practice for Grounding of Industrial and
      Commercial Power Systems.

1.4 QUALITY ASSURANCE:
A. NEC Compliance: Comply with Article 250 of the NEC for grounding.
B. Approval: All grounding shall be in accordance with the requirements of, and shall be subject
to the approval of the Engineer and the local electrical inspection department.
C. UL Label: All grounding products shall be UL-labeled.
D. Manufacturers: Provide grounding products complying with these specifications and as
manufactured by Copperweld and Cadweld.

1.5 SUBMITTALS:
A. Shop Drawing submittals shall include, but not be limited to, the following:
   1. A complete grounding system diagram for special grounding systems.
   2. Cut sheets of grounding products.
   3. Additional information as required in Section 260001, “Electrical General Provisions”.

1.6 STORAGE AND HANDLING:
A. Store grounding products in a clean, dry space.
PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

A. General: For each electrical grounding connection, provide a complete assembly of materials to construct a completely grounded electrical system.

B. Raceways: Raceways for grounding conductors shall be as specified in Section 26 05 33 "Electrical Raceways", and Section 26 05 34, "Electrical Boxes".

C. Cable, Wire, and Connectors: Grounding cable, wire and connectors shall be as specified in Section 26 05 19, "Low Voltage Conductors and Cables".

D. Ground Clamps: Ground clamps for connecting grounding conductors to copper, brass, or lead pipes shall be made of copper and if pipes are of steel or iron, the ground clamps should be made of galvanized iron. These clamps shall be designed to provide permanent and positive pressure and to avoid mechanical injury to the pipe. Use exothermic welds for connecting ground wires to ground rods, ground electrodes, building steel, for all below grade counterpoise ground grids, and elsewhere where noted on the Drawings.

E. Ground Conductors and Jumpers: Grounding conductors and jumpers shall be connected to each other and to items to be grounded by means of approved type pressure connectors, clamps and other suitable methods approved by the Engineer. No solder connections shall be made.

F. Grounding Electrode Rods: Grounding electrode rods used shall be a minimum of 3/4" diameter by 10' long, steel core and thick copper jacket. All concrete encased or direct buried underground grounding electrode conductors shall be of lead alloy-coated copper, Class B, stranded, conforming to ASTM A189.

G. Exothermic Welds: Use cadweld or an approved equal system of exothermic welding for welded grounding connections where shown on the Drawings or specified.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL GROUNDING:

A. General: Install grounding connections as shown and specified, in accordance with applicable portions of the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended functions.

B. Grounding Electrode System: Each service neutral and ground bus shall be connected to the incoming cold water piping system to the building on the street side of the building water meter. Provide a bonding jumper around the water meter. The main grounding conductor shall be sized as shown and shall be run in conduit. The cold water pipe ground shall be supplemented as required by NEC, Article 250 H, and as required by the local inspection department.

C. Bonding: All metallic piping systems and building steel shall be effectively bonded to the electrical grounding system in accordance with Article 250 of the NEC. Install bonding jumpers to all piping systems and building steel.

D. Building Equipment Grounding System: The building equipment grounding system shall consist of the ground wire and electrically continuous metallic conduit system as shown. Every item of equipment served by the electrical system shall be bonded to the building equipment ground. Portions of metallic piping and duct systems which are electrically isolated shall be bonded to the equipment grounding system with a flexible bonding jumper.
E. **System Neutral**: The system neutral shall be grounded to the grounding electrode system at the service entrance only, and shall be kept isolated from the building grounding system throughout the building. The neutral of separately derived systems shall be grounded at one point as specified hereinbelow.

F. **Miscellaneous**: Provide bonding and grounding wires run in conduit and sized per the NEC in accordance with the local electrical inspection department and the NEC. Metallic piping and duct systems which enter the building shall be grounded at the point of entry to the building, in accordance with the NEC.

G. **Continuity**: Continuity of the building equipment grounding system shall be maintained throughout the project. Grounding jumpers shall be installed across conduit expansion fittings, all liquidtight flexible metal and flexible metal conduit, light fixture pigtails in excess of 6', and all other non-electrically continuous raceway fittings.

H. **Main Conductors**: All main grounding conductors shall be stranded copper conductors, sized as shown or per the NEC, and run in a suitable raceway. All main grounding conductors shall be continuous without joints or splices over their entire length.

I. **Special Grounding**: Provide special grounding systems where shown on the Drawings.

J. **Separately Derived System Grounding**: Bond the case and neutral of each transformer directly to the nearest available effectively grounded structural metal member of the structure, the nearest available effectively grounded metal water pipe, or in accordance with the local electrical inspection department. Flexible conduit shall not be used as a ground path to a transformer.

K. **Voice/Data Equipment Grounding**: Provide a ground conductor from voice/data terminal provisions to the building grounding system as required by the local Telephone Company.

L. **Fluorescent Fixtures**: Carefully and securely ground all fluorescent fixture bodies to the conduit grounding system. Flexible conduit longer than 6' shall not be considered a ground path.

M. **Receptacles**: Ground all grounding type receptacles with a separate ground wire, where present in the branch circuit. Further, ground each outlet by the use of an approved grounding clip attached to the junction box in such a position to be readily inspected on removal of the coverplate; or by the use of an approved grounding yoke type receptacle.

N. **Isolated Ground Receptacles**: Where isolated ground receptacles are shown on the Drawings, ground each isolated ground receptacle with a separate insulated ground wire; this ground wire shall not be connected to the outlet box. Ground each isolated ground receptacle outlet box with a separate grounding conductor unless a metal raceway is to be used and effectively grounds the outlet box.

O. **Motor Frames**: Ground the frame of each motor with a properly sized separate ground wire around the liquidtight flexible conduit.

P. **Rigid Nonmetallic Conduit Systems**: Install a continuous grounding conductor in accordance with NEC.

Q. **Feeder and Branch Circuits**: Provide a separate, insulated equipment grounding conductor in each feeder or branch circuit. Terminate each end on a grounding lug, bus, or bushing.

R. **Bolted Connections**: Connections requiring bolting shall be made up with Monel metal bolts, washers, and nuts. Connections shall be made only after surfaces have been cleaned, or ground to expose virgin metal. No strap grounding clamps shall be used.

S. **Power Feeders**: Ground the raceway, shield (where applicable), armor (where applicable), and ground conductors in 5/15 kV and 600 volt power feeders in accordance with the NEC. Bond all pull boxes and splice boxes in accordance with the NEC.
T. **Branch Circuits**: Install an insulated ground wire, sized per the NEC, in all branch circuits.

3.2 **COORDINATION**:

A. **General**: Coordinate installation of grounding connections for equipment with equipment installation work. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. **Connections**: Use exothermic welds for connecting bonding and grounding conductors to ground rods, to counterpoise, structural steel, piping systems, and elsewhere where shown on the Drawings. Provide all accessories required for a complete installation.

3.3 **TESTING**:

A. **Ground Resistance Test**: Perform a ground resistance test on the building grounding systems for comparison to future inspection and testing data by the Owner. Service ground resistance shall not exceed 25 ohms. Overall system resistance shall not exceed 25 ohms. Test shall be performed using a AEMC Model # 3710 or a fall-of-potential test operated in accordance with the test instrument manufacturers operating/test procedure. The test shall not be performed immediately following wet weather conditions. If multiple grounding electrodes are necessary these electrodes shall be connected in series not in parallel.

B. **Submittals**: Contractor shall furnish all instruments and personnel required for tests. Submit two copies of certified test results for Owner's record and submit four copies of certified test results to Architect for review. Test reports shall include date and time of tests, relative humidity, test results, temperature, and weather conditions.

END OF SECTION 260526
PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions and Supplementary General Conditions, Division 1 General Requirements, and 26 00 01 Electrical General Provisions, apply to this section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide electrical raceway and fitting work as shown, scheduled, indicated, and specified.

B. Conduit Systems: All electrical conductors shall be installed in conduit. Conduit shall be as specified herein. In addition, empty conduit shall be installed for the voice/data system and for other systems as indicated on the Drawings and in the Specifications.

C. Types: The types of electrical raceways and fittings required for the project include, but are not limited to, the following:
   1. Rigid steel (RGS) and intermediate metal conduit (IMC).
   2. PVC-coated rigid steel conduit.
   3. Electrical metallic tubing (EMT).
   4. Flexible metal conduit.
   5. Liquidtight flexible metal conduit.
   6. Rigid nonmetallic conduit.

1.3 STANDARDS:

A. Products and installation shall comply with applicable sections of the following standards:
   1. ANSI C80.1 Rigid Steel Conduit, Zinc-Coated.
   2. ANSI C80.6 Intermediate Metal Conduit, Zinc-Coated.
   3. ANSI C80.3 Electrical Metallic Tubing, Zinc Coated.
   4. ANSI/NEMA FB 1 Fittings and Supports for Conduit and Cable Assemblies.
   5. NEMA TC 3 PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.4 QUALITY ASSURANCE:

A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
   1. Rigid Steel and Intermediate Metal Conduit:
      a. Allied Tube & Conduit Corporation.
      b. Republic Steel Corporation.
      c. Western Tube
      d. Wheatland.
   2. PVC-coated Rigid Steel:
      a. CalConduit.
3. Electrical Metallic Tubing:
   a. Allied Tube & Conduit Corporation.
   b. Republic Steel Corporation.
   c. Western Tube
   d. Wheatland.

4. Flexible Metal and Liquidtight Flexible Metal:
   a. AFC.
   b. Alflex
   c. Anaconda Metal Hose.
   d. Electri-Flex Company.
   e. Flexi-Guard, Inc.
   f. Wheatland.

5. Rigid Nonmetallic Conduit and Innerduct:
   a. Carlon.
   b. Cantex.
   c. Triangle PWC, Inc.

6. Raceway Fittings:
   b. Cantex (PVC).
   c. Carlon (PVC).
   d. Crouse Hinds.
   e. Efcor Division.
   f. O. Z. Gedney Company.
   g. Raco, Inc.
   h. Republic Steel Corporation.
   i. Steel City.
   j. Thomas and Betts.

7. Ductbank Spacers:
   a. Formex.
   b. Carlon.

8. Precast Manholes, Pull Boxes and Accessories:
   a. Brooks.
   b. A. B. Chance.

B. **UL Label**: All electrical raceways and fittings shall be UL-listed and labeled.
C. **NEMA Compliance**: All electrical raceways and fittings shall comply with NEMA standards applicable to raceway construction.
D. **NEC Compliance**: All electrical raceways and fittings shall comply with NEC requirements applicable to construction and installation.

1.5 **SUBMITTALS**:

   A. Shop drawing submittals shall include, but not be limited to, the following:
1. The Contractor shall submit to the Engineer for review, a list of the proposed manufacturers of electrical raceways and fittings selected from the manufacturers listed herein. The Contractor may install conduit and fittings furnished by any manufacturer listed on the approved submittal.

2. Cut sheets of electrical raceways and fittings.

3. Manufacturers data on manholes, pull boxes and accessories.

4. Additional information as required in Section 260001, “Electrical General Provisions”.

1.6 STORAGE AND HANDLING:

A. Handle raceways and fittings carefully to avoid damage, breaking, denting and scoring. Damaged materials shall not be installed.

B. Store raceways and fittings in a clean dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

A. General:

1. Provide metal conduit, tubing, and fittings of the type, grade, size, and weight (wall thickness) as shown and required for each service. Where type and grade are not indicated, provide proper selection determined by this Section to fulfill the wiring requirements and complying with the NEC for electrical raceways.

2. For each electrical raceway system indicated, provide a complete assembly of conduit, tubing, or duct with fittings, including, but not necessarily limited to, connectors, nipples, couplings, expansion fittings, bushings, locknuts, other components and accessories as needed to form a complete system of the type indicated.

3. Conduit fittings shall be designed and approved for the specific use intended. Conduit fittings, including flexible, shall have insulated throats or bushings. Rigid conduits shall have insulated bushings, except insulated throat grounding bushings shall be used on all conduits without ground conductors and where required by N.E.C. Article 250.

B. Rigid Steel or Intermediate Metal Conduit: Rigid Steel shall be UL 6 and ANSI C80.1, hot-dipped galvanized steel. Intermediate Steel shall be UL 1242 and ANSI C80.6, hot-dipped galvanized steel. Both ends of conduits shall be threaded with factory-installed thread protectors. Fittings shall be threaded Type UL 6/1242 and ANSI C80.1 and C80.6, hot-dipped galvanized steel. Expansion fittings shall be OZ Type "DX", Appleton Type "XJ", Crouse-Hinds Type "XC" or an approved equal and shall have bonding jumpers.

C. PVC Externally-Coated Rigid Steel Conduit: Shall be ANSI C80.1 hot-dipped galvanized rigid steel conduit with an external 0.040" minimum PVC protective coating per NEMA Standard RN1. Both ends of conduit shall be threaded and thread protectors shall be factory-installed. Fittings shall be threaded type ANSI C80.4, hot-dipped galvanized with a 0.055" minimum PVC coating to match the conduit.

D. Electrical Metallic Tubing: Shall be UL 797 and ANSI C80.3 galvanized steel with plain ends. Fittings, couplings and connectors shall be UL 797 and ANSI C80.4 galvanized steel type. Fittings, couplings and connectors shall be all steel set-screw type.
Compression type fittings, couplings and connectors shall be used where EMT
cable is cast in concrete. All EMT connectors shall have insulated throats or
bushings.

E. Flexible Conduit:
   1. Flexible Metal Conduit: UL 1, zinc-coated steel
   2. Flexible Metal Conduit Fittings: UL 1, zinc-coated steel, insulated throat.
   3. Liquidtight Flexible Metal Conduit: Liquidtight flexible metal conduit comprised of
      single strip, continuous, flexible, interlocked, double-wrapped, steel, galvanized
      inside and outside; forming smooth internal wiring channel; with liquidtight jacket
      of flexible polyvinyl chloride (PVC) or neoprene.

F. Liquidtight Flexible Metal Conduit Fittings: UL 1, liquidtight, zinc-coated steel, neoprene
   gaskets and O-rings, insulated throat.

G. Nonmetallic Conduit and Fittings:
   1. Schedule 40 Rigid PVC Conduit: Per UL 651, and NEMA TC 2, 90°C conductor
      temperature rating.
   2. Schedule 80 Rigid PVC Conduit: Per UL 651 and NEMA TC 2, 90°C conductor
      temperature rating.
   3. Type "EB" Encased Burial PVC Conduit: Per UL 651A and NEMA TC 8, ASTM
      F512 - heavy wall, 90°C conductor temperature rating.
   4. Quaduct PVC Conduit: Composite duct consisting of four nominal 1-1/2"
      Schedule 40 PVC conduits with an integral spacer, as manufactured by Teleduct
      Corporation, Logan, Ohio, (800)433-6931.
   5. PVC Conduit Fittings: Per NEMA TC 3 and compatible with PVC conduit system.
   6. Ductbank Spacers: Spacers shall be interlocking plastic designed for the conduit
      sizes and nominal 3" spacing being used.

H. Nonmetallic Innerduct:
   1. Innerduct: PVC corrugated flexible conduit, Carlon Optic-Gard PVC or an
      approved equal. Duct shall be available in one inch (1"), 1-1/4", 1-1/2" and 2"
      sizes and orange, gray and white colors.
   2. Couplings: PVC type, external, solvent cement type.

I. Conduit Tubing Accessories: Provide ANSI/NEMA FB I conduit and tubing accessories
   including straps, hangers and expansion joints as recommended by the conduit and
   tubing manufacturer and as specified in this Section.

J. Precast Concrete Manholes:
   1. General: Provide precast concrete manholes as detailed on the Drawings and as
      required for installation of new ductbank systems and connection to existing
ductbank systems at locations shown on the Drawings.
   2. Design: Manholes shall be steel reinforced and the complete manhole assembly
      shall be designed for H-20-44 bridge loading. Submittals shall clearly indicate all
      dimensions and reinforcing steel.
   3. Concrete: Manholes shall be constructed using concrete with a 4500 psi 28 day
      strength. Concrete mix shall be designed in accordance with ASTM standards.
   4. Reinforcing Steel: Steel shall be intermediate or hard grade billet steel
      conforming to ASTM A15, deformed in accordance with ASTM A305.
   5. Manholes: Manhole and pull box covers shall be cast iron cover mounted in a
      30" Type "B" or "WRM" frame and shall be traffic type for heavy vehicular traffic.
The frame and neck shall be doweled into the manhole to prevent movement
away from the opening. Power manhole and pull box covers shall be marked
“ELECTRIC”. Communication manhole and pull box covers shall be marked "COMMUNICATIONS". Voice manhole and pull box covers shall be marked "TELEPHONE". Data manhole and pull box covers shall be marked "DATA".

6. Conduit Entry: Plastic conduits shall include a bell end inside the manhole or pull box, mounted flush and grouted to seal openings. Precast fiber type terminators shall be provided for each ductbank entry.

7. Grounding: A #4/0 bare copper ground wire shall penetrate the side wall in the bottom section of each manhole and pull box and extend 48” inside and outside of the manhole pull box.

8. Accessories: Knockouts, cable racks, sumps, steps, joint seals and other accessories shown on the Drawings or required for a complete installation shall be provided.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Install electrical raceways and fittings as shown, in accordance with the manufacturer's written instructions, the applicable requirements of the NEC, and in accordance with recognized industry practices to ensure that products serve the intended function. Complete electrical raceway installation before starting the installation of wire and cable.

B. Conduit Size: Minimum conduit size for power wiring shall be 3/4", except that 1/2" flexible metallic conduit may be used for fixture whips. Maximum conduit size for EMT shall be 2" for voice/data conduits which may be EMT up to 4". Minimum conduit size for control wiring shall be 3/4". Minimum conduit size for voice/data wiring shall be one inch (1").

C. Rigid Steel and Intermediate Metal Conduit: Use rigid steel or intermediate metal conduit to run all electrical raceway systems where exposed to weather; in damp or wet locations; where subject to physical damage; and where cast in concrete walls or floor slabs which have waterproof membranes and where cast in masonry walls. Use rigid steel conduit for all power feeders, unless otherwise noted. Use rigid steel or IMC conduit for all feeders. IMC conduit shall not be used in sizes larger than 4”. Use threaded type couplings and fittings. Split type couplings and fittings are not acceptable.

D. PVC-coated Rigid Steel: Use polyvinyl chloride (PVC) externally-coated rigid steel conduit and fittings for electrical raceway systems for branch circuits to wet areas; where exposed outdoors; and elsewhere, as shown. Conduit and fittings shall be installed such that the PVC-coating is continuous and watertight such that no portion of the metal conduit or fittings is exposed to moisture.

E. Electrical Metallic Tubing (EMT): Use EMT for branch circuit electrical raceway systems where concealed in furred ceilings or in walls; exposed inside where not exposed to physical damage; or cast in concrete walls or floor slabs which do not have waterproof membranes. EMT conduit shall not be installed where exposed to weather or in wet locations. Use compression or set-screw type fittings, couplings and connectors made-up tight for all conduit sizes. Use watertight fittings, couplings and connectors where required. Where cast in concrete and floor slabs, use concrete tight fittings, couplings and connectors and terminate conduit in a box cast in concrete, or with rigid steel conduit turnouts from concrete. Crimp type fittings, couplings and connectors are not acceptable.
**3.2 INTERIOR CONDUIT SYSTEM:**

**A.** Ground all metallic conduit in accordance with the requirements of the latest edition of the NEC.

**B.** Install all conduits as a complete system without conductors, continuous from outlet to outlet and from fitting to fitting. Make up threaded joints of conduit carefully in such a manner as to ensure a tight joint. Field-cut threads shall be cold-galvanized after cutting. The entire conduit system shall be secured at all joints and boxes in such a manner that each system shall be electrically continuous throughout. Fasten the entire conduit system securely into position. A run of conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than the equivalent of four quarter bends, including those bends located immediately at the outlet or fitting. Install approved expansion fittings in all conduit runs as specified in paragraph 3.2/P.

**C.** Ream all ends of conduit properly to remove rough edges. Whenever a rigid steel or IMC conduit enters a switchboard, panelboard, enclosure, or box, it shall be securely fastened by the use of a locknut inside and outside and an approved insulating bushing shall be installed. Insulated grounding bushings shall be installed on all conduits without ground conductors and where required by NEC Article 250. Whenever an EMT conduit enters a switchboard, panelboard, enclosure, or box, it shall be securely fastened by use of an insulated throat connector or a connector with an insulating bushing. Insulated grounding bushings shall be installed on all conduits without ground conductors and where required by NEC Article 250. Whenever an EMT conduit enters a switchboard, panelboard, enclosure, or box, it shall be securely fastened by use of an insulated throat connector or a connector with an insulating bushing. Lay out and install all conduit systems as to avoid all other services or systems, the proximity of which may prove injurious to the conduit or the wires or conductors which the conduit confines.

**D.** Conceal conduit systems in finished areas. Concealed metallic conduits shall be run in a direct manner, basically parallel to, and at right angles with the lines of the building, and with as long a bend as possible. Conduit may be exposed in mechanical rooms and where otherwise shown or indicated. On exposed systems, run the conduit parallel or perpendicular to the structural features of the building and rigidly support with malleable iron conduit clamps at intervals as required by NEC or on conduit racks, neatly racked and bent in a smooth radius at corners insofar as practicable. All bends shall be field-made using an approved bending machine designed for the purpose, or using standard ells having a radius not less than that shown in Chapter 9, Table 2 of the National Electrical Code.
Electrical Code, and with approved fittings or connectors. All bends shall be free from dents or flattening.

E. All conduits shall be run without traps. Where traps are unavoidable, a junction or pull box shall be placed at the low point. Metallic conduit systems which are exposed to the weather or water shall be made watertight. As soon as conduit has been permanently installed in place, conduit shall be capped or plugged with standard accessories. All metallic conduits shall be swabbed after plaster and dry wall is finished and dry.

F. Support exposed raceway or grouped concealed raceways on galvanized channel using compatible galvanized fittings (bolts, beam clamps and similar items) and galvanized threaded rod pendants to secure raceway to channel and channel to structure. Support single conduit runs using a properly sized galvanized conduit hanger with galvanized closure bolt/nut and threaded rod. Support-spacing shall not exceed 10’ apart for all EMT/IMC conduit and rigid conduit 2” and smaller and 15’ apart for rigid conduit 2-1/2” and larger and within 3’ from boxes and changes in direction. Support flexible conduit on maximum 4-1/2’ centers and within one foot (1’) of boxes. All raceway support system materials shall be galvanized and manufactured by Kindorf, Unistrut, Superstrut, Caddy, or Spring Steel Fasteners, Inc. Provide chrome or nickel-plated escutcheon plates on all conduit passing through walls and ceilings in finished areas.

G. Support 1” and smaller EMT conduit concealed in ceiling cavities with No. 13 AWG galvanized iron wire pendants, spaced not to exceed 10’ apart and 3’ from boxes and changes in direction, secured to conduit with clips and properly secured to structure. Perforated strap shall not be used for conduit supports.

H. Make all joints and connections to ensure mechanical strength and electrical continuity. PVC conduit shall be joined, or have fittings attached, by using a fusing (solvent) compound recommended by and applied as instructed by, the conduit manufacturer.

I. Run conduit to avoid proximity to heat producing equipment, piping and flues, keeping a minimum of 8” clear. Whenever possible, install horizontal raceway runs above water piping. Unless shown otherwise, do not install conduit horizontally in concrete slabs without written approval. All roof penetrations shall be made in adequate time to allow the roofer to make proper flashings.

J. Carefully review architectural, structural, mechanical, plumbing, and electrical Drawings and place boxes and conduit to avoid conflicts with structural members or other general construction.

K. Conduit shall not be embedded in structural slabs without prior written permission from the Structural Engineer. Conduits embedded in structural slabs shall be installed in the middle of the slab below the top and above the bottom reinforcing steel. Maintain a minimum concrete coverage of one inch (1”) except where penetration is made.

L. Furnish sleeves for timely placing in construction for all conduit passing through concrete walls, partitions, beams, floors, and roofs while same are under construction.

M. All conduit passing through the housing on connected equipment, shall pass through a cleanly cut hole protected with an approved grommet.

N. Metallic conduit installed below grade shall have its entire length painted with two coats of protective finish unless encased in concrete. Each coat shall consist of 5 mils of PPG "Coat Cat Epoxy Coating" applied in accordance with the manufacturer's recommendations. The entire length of metallic conduit, including fittings, shall be protected to a point 6” above finished grade (or concrete slab).
O. Coordinate locations of raceways in fire rated partitions so as not to affect the fire rating of the partition. Notify the Architect in writing where additional construction is required to maintain the partition fire rating.

P. Install expansion fittings in all conduit as follows:
   1. All conduits crossing building expansion joints; unless some other form of thermal expansion compensation is approved in writing by the Engineer.
   2. All conduit straight runs in excess of 200' and on 400' centers in all longer conduit runs.
   3. Conduits entering environmental rooms.
   4. Locations subject to thermal expansion and as required by NEC.
   5. Unless expansion fitting has an integral bonding braid an external braid, approved for the purpose, shall be installed around the fitting.

Q. Provide EMT conduit risers and flush outlet boxes in walls for outlets for telecommunications, fire alarm devices, HVAC system thermostats, security system devices, radio system outlets or other low voltage systems.

3.3 EXTERIOR CONDUIT SYSTEMS:

A. Exterior conduit systems shall meet all of the general installation requirements for interior conduit systems.

B. All exterior conduit systems shall be completely watertight. All hangers, fasteners, and supports used with exterior conduit systems shall be hot dip galvanized.

C. Conduit routed across roofs shall be attached to 4” x 4” redwood or penta-treated pine sleepers spaced on maximum 5’-0” intervals, unless otherwise detailed on the Drawings. Sleepers shall be installed in pitch pans or as otherwise detailed on the Drawings.

D. Install underground conduits with sealing glands equal to OZ Type "FSK" or approved equal, exterior to the conduits and OZ Type "CSB" or approved equal internally at the point where conduits enter the building, to prevent water seepage.

E. Install conduits outside the building lines a minimum of 36” below grade, unless noted otherwise on the Drawings. Maintain 12” of earth or 2” of concrete separation between electrical conduits and other services or utilities below grade.

3.4 POWER DUCTBANK SYSTEMS:

A. Power ductbanks shall be of individual conduit. Conduit shall be rigid PVC Schedule 40 except that PVC coated rigid steel conduit shall be used for the final 10’ at the beginning and end of each ductbank and for all 90 degree elbows.

B. The power ductbank shall be routed underground and the top of the concrete envelope shall be not less than 36” below grade.

C. Changes in direction of ductbank runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished by long sweep bends having a minimum radius of curvature of 5’. All bends in a run shall be separated by a minimum of 10’ of straight conduit, where possible.

D. During construction, partially completed ductbanks shall be protected from the entrance of debris such as mud, sand, and dirt by means of suitable conduit plugs. As each section of the ductbank is completed, a testing mandrel shall be drawn through each conduit. A brush with stiff bristles shall be drawn through until each conduit is clear of all particles of earth, sand, or gravel. Conduit plugs shall then be immediately installed.
E. Install underground conduits with sealing glands equal to OZ Type "FSK" exterior to the conduit and OZ Type "CSB", or equal internally at the point where conduits enter the building to prevent water seepage into the building.

3.5 VOICE/DATA DUCTBANK SYSTEMS:

A. Exterior voice/data ductbanks shall be of individual PVC conduit and direct buried without concrete encasement. Conduit shall be rigid PVC Schedule 40. Interior ductbanks shall be of individual conduit and conduit shall be EMT. Unless shown otherwise, the type of conduit used shall not be mixed in any one ductbank and shall not be smaller than 4" in diameter. Install innerducts and pullstrings in conduit and ductbank where noted.

B. Where the voice/data ductbank is routed underground, the top of the ductbank shall be not less than 36" below grade.

C. Changes in direction of voice/data ductbank runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished by long sweep bends having a minimum radius of curvature of 5’. All turn ups to above grade shall be long radius PVC coated RGS elbows, coated as specified in paragraph 3.02N. All bends in a run shall be separated by a minimum of 10’ where possible. There shall be no more than two 90 degree bends in any run of voice/data ductbank.

D. During construction, partially completed ductbanks shall be protected from the entrance of debris such as mud, sand, and dirt by means of suitable conduit plugs. As each section of the ductbank is completed, a testing mandrel with diameter 1/4” smaller than the conduit shall be drawn through each conduit. A brush with stiff bristles shall be drawn through until each conduit is clear of all particles of earth, sand, or gravel. Conduit plugs shall then be immediately installed.

E. Sleeves for voice/data ductbank passing through basement walls shall be rigid steel conduit and shall extend a minimum of 24” outside basement wall.

F. Ducts in concrete encased ductbanks shall be independently supported by interlocking modular spacers. Spacers shall provide separation between adjacent ducts as shown on the Drawings. Spacers shall be installed at 6’ maximum intervals.

G. Ducts in concrete encased ductbanks shall be terminated in manholes, pull boxes, and vaults with interlocking terminators. A watertight tapered plug shall be furnished and installed in unused duct openings. Where terminators are installed in new work, they shall be poured-in-place.

H. Voice/data ductbank shall be installed per Telephone Company standards.

3.6 VOICE/DATA AND SIGNAL SYSTEM RACEWAYS:

A. General: Conduit shall be installed in accordance with the previous specified requirements for conduit and tubing and with the additional requirements that no length of run shall exceed 100’ for 1/2” and 3/4” trade sizes, and 150’ for one inch (1”) or larger trade sizes, and shall not contain more than two 90 degree bends or the equivalent thereof. Pull or junction boxes shall be installed to comply with these requirements. Empty voice/data and signal system raceways shall include a pull wire or cord, as described in Paragraph 3.8 hereinbelow. Install innerducts with pullcords in raceways where noted.

3.7 EMPTY CONDUIT RACEWAY SYSTEMS:
A. General: Empty conduit in which wire is to be installed by others shall have pull wires installed. The pull wire shall be No. 14 AWG zinc-coated steel, or plastic having not less than 200 pounds tensile strength. Not less than 12” of slack shall be left at each end of the pull wire.

3.8 IDENTIFICATION:
A. General: Refer to Section 260553, "Identification for Electrical Systems", for requirements concerning painting and marking of raceways and fittings.

END OF SECTION 260533
SECTION 260534

ELECTRICAL BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions and Supplementary General Conditions, Division 1 General Requirements, and 26 00 01 Electrical General Provisions, apply to this section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide electrical box and fitting work as shown, scheduled, indicated, and as specified.

B. Types: The types of electrical boxes and fittings required for the project include, but are not limited to, the following:

1. Outlet boxes.
2. Junction boxes.
3. Pull boxes.
5. Floor boxes.
6. Fire-rated poke-thru boxes.
7. Conduit bodies.
8. Bushings.
9. Locknuts.

1.3 STANDARDS:

A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:

1. ANSI/NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.4 QUALITY ASSURANCE:

A. Manufacturers: Provide products complying with these specifications and produced by one of the following:

1. Interior Outlet Boxes:
   b. Arrow Conduit and Fittings Corporation.
   c. Bowers.
   d. O. Z. Gedney Company.
   e. National Electric Products Company.
   f. Raco
   g. Star Sheet Metal.
h. Steel City, Midland-Ross Corporation.

2. Weatherproof Outlet Boxes:
   c. Harvey Hubbell, Inc.
   d. Pyle-National Company.
   e. Raco
   f. Red Dot.

3. Junction and Pull Boxes:
   b. Arrow-Hart, Inc.
   c. O. Z. Gedney Company.
   d. General Electric Company.
   g. Square D Company.
   h. Unity.

4. Cabinets:
   b. Hoffman Engineering Company
   c. Square D Company.
   d. Westinghouse.

5. Floor Boxes:
   a. Harvey Hubbell, Inc.
   b. Raceway Components, Inc.
   c. Steel City, Midland-Ross Corporation.
   d. Walker Parkersburg Division of Textron, Inc.

6. Fire-rated Poke-thru Boxes:
   a. Harvey Hubbell, Inc.
   b. Raceway Products.
   c. Square D Company.
   d. Steel City, Midland-Ross Corporation.
   e. Walker Parkersburg Division of Textron, Inc.

7. Conduit Bodies:
   d. Pyle-National Company.

8. Bushings, Knockout Closures and Locknuts:
   a. Allen-Stevens Conduit Fittings Corporation.
   b. Allied Metal Stamping, Inc.
   c. Appleton Electric Company.
   d. Carr Company.
   e. Raco, Inc.
   f. Steel City, Midland-Ross Corporation.
   g. Thomas and Betts Company, Inc.

B. UL Label: All electrical boxes and fittings shall be UL-labeled.
1.5 SUBMITTALS:

A. Shop Drawing submittals shall include, but not be limited to, the following:
   1. The Contractor shall submit to the Engineer for review, a list of proposed manufacturers of electrical boxes and fittings selected from the manufacturers listed herein. The Contractor may install electrical boxes and fittings furnished by any manufacturer listed on the approved submittal.
   2. Cut sheets of electrical boxes and fittings.
   3. Cut sheets on cabinets.
   4. Drawings of any special boxes which must be fabricated, including construction details.
   5. Additional information as required in Section 260001, “Electrical General Provisions”.

1.6 STORAGE AND HANDLING:

A. Handle electrical boxes and fittings carefully to avoid damage, breaking, denting, and scoring. Damaged equipment or materials shall not be installed.

B. Store electrical boxes and fittings in a clean dry space and protect from weather.

PART 2 - PRODUCTS

2.1 FABRICATED MATERIALS:

A. Interior Outlet Boxes: Provide galvanized steel interior outlet wiring boxes, of the type, shape, and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices. Provide "gang" boxes where devices are shown to be grouped.

   1. Type for Various Locations:
    a. Ceilings: 4" square, 2-1/8" deep.
    b. Standard Partitions, Where 1/2" and 3/4" Conduits are Employed: 4" square by 2-1/8" deep boxes with one-gang or two-gang plaster covers shall be used.
    c. Thin Partitions Measuring 3-1/2" or Less: 4" square by 1-1/2" deep boxes with one-gang or two-gang covers shall be used.
    d. Standard Partitions, Where Conduits of a Size Greater than 3/4" are Employed: 4-11/16" square by 2-1/8" deep boxes with one-gang or two-gang plaster covers shall be used.
    e. Masonry Walls: Galvanized switch boxes made especially for masonry installations; depths of boxes must be properly coordinated for each specific installation.
    f. Poured Concrete: Provide plenum type boxes without any holes and with reset knockouts. Where extension rings are used to offset conduit between wall reinforcing steel, joint between extension ring and box shall be sealed to prevent concrete from entering box during pour.
    g. Return Air Ceiling Plenum Boxes: In return air ceiling plenums, where 1/2" and 3/4" conduits are employed, 4" square by 2-1/8" deep plenum boxes shall be used.
    h. Surface: Type "FS" or Type "FD" box with surface cover.
ELECTRICAL BOXES

i. Special: Where above types are not suitable, furnish boxes to suit the use taking into account space available, appearance, and Code requirements.

2. Switch Boxes:
   a. One-gang/Two-gang Switch Boxes in Standard Walls or Partitions: Shall be 3" x 2" square corner boxes by 2-1/2" deep with appropriate mounting bracket for attachment to studs.
   b. One-gang/Two-gang Switch Boxes in Thin Walls or Partitions: Shall be 3" x 2" square corner boxes by 1-1/2" deep with appropriate mounting bracket for attachment to studs.
   c. Three-gang and Up Switch Boxes in Standard Walls or Partitions: Shall be 4-1/2" wide solid gang boxes, with appropriate "gang" plaster covers as required.

3. Interior Outlet Box Accessories: Provide outlet box accessories as required for each installation, including proper covers or wall device plates, mounting brackets, wallboard hangers, extension rings, plaster rings for all boxes in plaster construction, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used, and meeting requirements of individual wiring situations.

B. Weatherproof Outlet Boxes: Provide hot-dipped galvanized cast iron weatherproof outlet wiring boxes, of the type, shape, and size, including depth of box, with threaded conduit ends, cast metal coverplate with spring-hinged waterproof caps suitably configured for each application, including face plate gasket and corrosion resistant fasteners.

C. Junction and Pull Boxes: Provide galvanized sheet steel junction and pull boxes, with screw-on covers and welded seams with stainless steel nuts, bolts, screws and washers, of the type, shape, and size, to suit each respective location and installation.
   1. Type for Various Locations:
      a. 100 Cubic Inches in Volume or Smaller: Standard outlet boxes with stamped knockouts.
      b. 150 Cubic Inches in Volume or Larger: Code gauge steel with sides formed and welded, screw covers unless shown to have hinged doors. Hinged doors with locking device same as furnished on panelboards. Knockouts factory-stamped or formed in field with a cutting tool to provide a clean symmetrically-cut hole.
      c. Exterior or Wet Areas: Weatherproof galvanized steel construction with proper gaskets and corrosion resistant fasteners. A parking garage is considered a wet area.

D. Cabinets: Provide cabinets of size and style noted on the Drawings.
   1. Cabinet fronts shall be steel. Other sheet metal for boxes shall be galvanized steel. Details of construction and methods of assembly shall meet the requirements of the Underwriters' Laboratories, Inc.
   2. The panel doors of cabinets shall be provided with locks. Single panel doors of cabinets shall have a lock with ring pull. Single doors 48" or longer and pairs of doors shall have a lock with vertical bolt operation, 3-point locking. Locks shall be keyed alike. Two keys shall be supplied for each cabinet.
   3. Cabinets shall have concealed hinges.
   4. Flush-mounted trim shall be fastened to cabinet with adjustable trim clamps. Fasteners for cabinets in concealed areas shall be concealed.
ELECTRICAL BOXES

5. Each voice/data cabinet shall be equipped with 3/4" plywood backboard covering entire inside rear surface and painted matte white.

6. Trims and doors shall have a suitable primer coat and a finish coat of the manufacturer’s standard color.

E. **Conduit Bodies:** Provide galvanized cast metal conduit bodies, of the type, shape and size, to suit each respective location and installation, constructed with threaded conduit ends, removable cover, and corrosion resistant screws.

F. **Bushings, Knockout Closures, and Locknuts:** Provide corrosion resistant punched-steel box knockout closures, conduit locknuts, gasketed locknuts, insulated conduit bushings and insulated grounding conduit bushings of the type and size to suit each respective use and installation.

PART 3 - EXECUTION

3.1 INSTALLATION OF BOXES AND FITTINGS:

A. Install electrical boxes and fittings as shown, in compliance with NEC requirements, or in accordance with the manufacturer’s written instructions and with recognized industry practices to ensure that the boxes and fittings serve the intended purposes. Where boxes are concealed in exterior walls, the continuity of the vapor barrier shall be maintained behind the box.

B. Use outlet and switch boxes for junctions on concealed conduit systems except in utility areas where exposed junction or pull boxes may be located.

C. Determine from the Drawings and by actual determination on the site, the exact location of each outlet. The outlet locations shall be modified from those shown to accommodate changes in door swings or to clear other interferences that may arise from job construction details, as well as modification to center them within room spaces. These modifications shall be made with no change in contract price and shall be a matter of job coordination. Check these conditions throughout the entire job and notify the Architect of discrepancies, as they may occur, to verify the modifications, if any, before proceeding with the installation of the work. Set wall boxes in advance of wall construction, blocked in place and secured. Set all wall boxes flush with the finish and install extension rings as required to extend boxes to the finished surfaces of special furring or wall finishes.

D. Install outlet boxes at heights as specified in Section 260501, "Electrical Basic Materials and Methods".

E. On exposed conduit systems provide pull boxes, junction boxes, wiring troughs, and cabinets wherever necessary for proper installation of various electrical systems.

F. Provide weatherproof boxes for interior and exterior locations exposed to weather or moisture.

G. Provide knockout closures to cap unused knockout holes where blanks have been removed.

H. Locate boxes and conduit bodies so as to ensure accessibility of electrical wiring.

I. Secure boxes rigidly to the substrate upon which they are being mounted, or solidly imbed boxes in concrete or masonry. Boxes shall not be permitted to move laterally. Boxes shall be secured between two studs. Two gang (single or double device) boxes may be connected to one stud using an approved bracket, except where specific dimensioned locations must be met. Box recessing depths shall comply with Article 314.24 of the National Electrical Code.
J. Boxes for any conduit system shall not be secured to the ceiling system, HVAC ductwork, or mechanical piping.

K. Provide junction and pull boxes for feeders and branch circuits where shown and where required by the NEC, regardless of whether boxes are shown or not.

L. Coordinate locations of boxes in fire rated partitions and slabs so as to not affect the fire rating of the partition or slab. Notify the Architect in writing where modifications or additional construction are required to maintain the partition or slab fire rating.

M. All junction boxes in accessible locations shall be marked with a permanent marker to identify the circuit(s) within the box.

N. Junction boxes utilized for emergency circuits shall be painted red in color.

O. Do not install boxes back-to-back in walls. Provide minimum 6" separation. Provide minimum 24" separation in acoustic-rated walls. If boxes are connected together, install flexible connection between the boxes and pack openings with fiberglass.

P. The following requirements shall apply to exposed as well as concealed conduit systems when "gang" boxes shall be used. These "gang" boxes shall have dimensions which are not smaller than those shown in the following table:

<table>
<thead>
<tr>
<th>NUMBER IN GANG</th>
<th>SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>4-1/2&quot; x 8-5/8&quot;</td>
</tr>
<tr>
<td>4</td>
<td>4-1/2&quot; x 10-1/2&quot;</td>
</tr>
<tr>
<td>5</td>
<td>4-1/2&quot; x 10-1/2&quot;</td>
</tr>
<tr>
<td>6</td>
<td>4-1/2&quot; x 14&quot;</td>
</tr>
</tbody>
</table>

Q. Switch boxes shall not be used as junction boxes.

R. Install boxes in walls without damaging wall insulation.

S. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

T. In inaccessible ceiling areas, position outlets and junction boxes within 6" of recessed luminaire, to be accessible through luminaire ceiling opening.

U. Outlet boxes supporting fixtures shall be securely anchored in place in an approved manner. Support outlet boxes and fixtures in acoustic ceiling areas from building structures, not from acoustic ceilings. Light fixture outlets shall be coordinated with mechanical and architectural equipment and elements to eliminate conflicts and provide a workable neat installation.

V. Set floor boxes level and flush with floor. Install nonrated floor boxes as detailed on the Architectural Drawings.

W. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.

X. Where outlet or switch boxes are not supported from studs or joists directly, they shall be supported by expandable clip type bar hangers, Appleton Catalog No. SX-18 or SX-26. In no case shall conduit be used to support switch or outlet boxes.

Y. Outlet boxes in plaster partitions shall be "shallow-type" set flush in wall so there is at least 5/8" plaster covering back of box.

Z. Refer to Section 26 05 53, "Identification for Electrical Systems", for applicable painting and marking of electrical boxes.

END OF SECTION 260534
PART 1 - GENERAL

1.1 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions and Supplementary General Conditions, Division 1 General Requirements, and 26 00 01 Electrical General Provisions, apply to this section.

1.2 DESCRIPTION OF WORK:
A. Work Included: Provide identification for electrical systems as shown, scheduled, indicated, and specified.
B. Types: The types of identification for electrical systems required for the project include, but are not limited to:
   1. Electrical system identification.
   2. Warning signs and operational tags.
   3. Cleaning and painting of electrical work.

1.3 SUBMITTALS:
A. Shop Drawing submittals shall include, but not be limited to, the following:
   1. Cut sheets and samples of Electrical System Identification products.
   2. Additional information as required in Section 260001, “Electrical General Provisions”.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING:
A. Deliver components in factory-fabricated water resistant packaging.
B. Handle components carefully to avoid damage to components, enclosures, and finish.
C. Store components in a clean, dry space and protect from weather.

PART 2 - PRODUCTS

2.1 MATERIALS:
A. General: Refer to PART 3 - EXECUTION of this Section and other Division 26 sections for basic electrical products and materials.

PART 3 - EXECUTION

3.1 ELECTRICAL SYSTEM IDENTIFICATION:
A. Identification of Equipment:
   1. All pieces of major electrical equipment shall have a manufacturer's label identifying the manufacturer's address, equipment model and serial numbers,
equipment size, and other pertinent data. Care shall be taken not to obliterate this nameplate in any way.

2. The Contractor shall make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, junction boxes, etc., by marking them. All items of equipment, pull boxes, junction boxes, etc., shall be clearly marked using engraved nameplates as hereinafter specified. The item of equipment shall indicate the same number as shown on the Drawings, where applicable.

3. Equipment nameplates shall be three ply laminated plastic, a minimum of 3/32" thick, black-white-black for normal power, red-white-red for emergency power, and blue-white-blue for UPS power. Letters shall be similar to Roman Gothic of a size that is legible (1/2" minimum for main nameplates and 3/8" minimum for branch device nameplates) and appropriate to the application. Attachment of nameplates shall be by stainless steel screws. Rivets or adhesives are not acceptable.

   a. Electrical equipment to be identified includes: All panelboards, disconnect switches, motor controller/starters, pull boxes, junction boxes, and similar equipment.

   b. Nameplates on disconnect switches, motor controller/starters, and panelboards shall give voltage and current characteristics and the source feeding the panel. Current characteristics shall indicate the size of the overcurrent devices serving the equipment and not the equipment current rating.

      Example:
      
      PANEL 1LA
      120/208V, 3 PH, 4 W, 225 A
      Fed from DPA-3
      Room 1.102

   c. Individual overcurrent devices and pilot lights in panelboards and similar equipment shall have nameplates showing the load served and its location, where remote. Nameplates on motor starters shall indicate variable speed, time delay operation, etc., where applicable.

   d. Blank nameplates shall be mounted on each spare or bussed space in motor control centers, and on each spare or space in distribution panels.

   e. Branch circuit panelboards shall have neatly typed circuit directories behind clear plastic. Identify circuits by room numbers. Room numbers shall be those finally selected by the Owner; not necessarily those given on contract Drawings. Spares and spaces shall be indicated with erasable pencil; not typed. Circuit numbers shall be provided in the directory and at each circuit breaker.

B. Conduit Systems: Provide adequate marking of major conduit which is exposed or concealed in accessible spaces, to distinguish each run as either a normal power, emergency power, fire alarm, control wiring or voice/data conduit. Except as otherwise indicated, use orange banding with black lettering except that emergency power and fire alarm conduit markers shall use red banding. Provide self-adhesive or snap-on type plastic markers. Indicate voltage ratings of conductors exceeding 250 volts. Locate markers at ends of conduit runs, near switches and other control devices, near items of equipment served by the conductors, at points where conduit passes through walls or floors, or enters non-accessible construction and at spacings of not more than 50' along
each run of exposed conduit. Switch-leg conduit and short branches for power connections need not be marked, except where conduit is larger than one inch (1”).

C. **Cable Tray Systems:** Provide engraved nameplates identifying cable tray systems as to use, on maximum 50' centers on all exposed tray systems and whenever a tray enters a room or concealed accessible location. Nameplate text shall be submitted to the Engineer for review.

D. **Underground Cable Identification:** Bury a continuous, preprinted, bright colored plastic ribbon cable marker, Brady No. 91600 Series or an approved equal with each underground cable (or group of cables), regardless of whether conductors are in conduit or direct buried. Locate each directly over cables, 6” to 8” below finished grade. Ribbons shall be detectable from above grade using a pipe or cable locator.

E. **Cable/Conductor Identification:** Coordinate a uniform and consistent scheme of color identification of power wiring throughout the building system. Identification shall be by the permanent color of the selected covering. On large conductors, secure identification by means of painted color banding or plastic tape.

1. Color scheme shall be as follows, [or as required to match the existing color coding in the building for 120/240 V systems with high leg provide Orange for phase B]:

<table>
<thead>
<tr>
<th>208/120 Volt</th>
<th>480/277 Volt</th>
<th>5 kV/15 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase A</td>
<td>Black</td>
<td>Brown</td>
</tr>
<tr>
<td>Phase B</td>
<td>Red</td>
<td>Purple</td>
</tr>
<tr>
<td>Phase C</td>
<td>Blue</td>
<td>Yellow</td>
</tr>
<tr>
<td>Neutral</td>
<td>White</td>
<td>Gray</td>
</tr>
<tr>
<td>Ground</td>
<td>Green</td>
<td>Green</td>
</tr>
</tbody>
</table>

2. Wiring for switches shall be same color as phase wire.
3. Colored insulation in sizes up through No. 10. Conductors No. 8 and larger may have black insulation, but color coded with 1/2” wide band of colored tape, at accessible locations.
4. Feeder cables shall be tagged in pull boxes, wireways, wiring gutters of panels, and at other accessible locations. Tags shall be fireproof, nonconductive material, approved by Architect.
5. Maintain same conductor color from service entrance to last device.

F. **Phase Rotation:** Phase rotation shall be maintained throughout the project.

1. Phase rotation shall be clockwise or counterclockwise, per serving power company standards, A-B-C, and identified as such left-to-right, top-to-bottom, and front-to-back with color coding as specified above at switchboards, panelboards, substations, transformers, motor control centers, motor starters, and similar locations.
2. Motor phase reversal, if necessary, shall be made at motor terminals.

G. **Branch Circuit and Control Wiring Tags:** All branch circuit and control wiring conductors shall be tagged using self-sticking vinyl cloth or mylar cloth wire markers. Embossed pressure sensitive plastic or metal ribbon markers will not be accepted. Tags shall be installed at all wiring splice, tap and termination points and shall correspond to the designs shown on the control wiring diagrams or panel schedules.

H. **Branch Circuit Pull Boxes and Junction Boxes:** Branch circuit pull boxes shall be neatly stenciled with a black permanent marker indicating the panel name and branch circuit number. Boxes on emergency power systems shall be painted red prior to marking.

I. **Panelboards:** All panelboards shall have wiring diagrams provided with each board.
J. Manufacturers: Provide electrical identification products as manufactured by Ideal, T&B, 3M, Panduit, Seaton, EMED Co. or an approved equal.

3.2 WARNING SIGNS AND OPERATIONAL TAGS:

A. Warning Signs: Provide warning signs where there is hazardous exposure associated with access to or operation of electrical facilities. Provide text of sufficient clarity and lettering of sufficient size to convey adequate information at each location; mount permanently in an appropriate and effective location. Comply with recognized industry standards for color and design.

B. Operational Tags: Where needed for proper and adequate information on operation and maintenance of electrical systems, provide tags of plasticized card stock, either preprinted or hand printed. Tags shall convey the message, example: "DO NOT OPEN THIS SWITCH WHEN BURNER IS OPERATING".

3.3 CLEANING AND PAINTING OF ELECTRICAL WORK:

A. Prime, protective and touch-up painting is included in the Work of this Division. Finish painting in equipment spaces, concealed locations, and other locations not exposed to the view of building occupants is included in the work of this Division. Finished painting in areas exposed to the view of building occupants is specified under Division 9.

B. All equipment and materials furnished by the electrical subcontractor shall be delivered to the job with suitable factory protective finish.

C. Electrical switchgear, disconnect switches, contactors, etc., with suitable factory-applied finishes shall not be repainted; except for aesthetic reasons where located in finished areas as directed by the Architect and in a color selected by the Architect. Where factory-applied finishes are damaged in transit, storage or installation, or before final acceptance, they shall be restored to factory-fresh condition by competent refinishers using the spray process.

D. All equipment not finished at the factory shall be given a prime coat and then finish painted with two coats of enamel in a color as directed by the Architect/Engineer. No nameplates on equipment shall be painted, and suitable protection shall be afforded such plates to prevent their being rendered illegible during the painting operations.

E. The surfaces to be finish-painted shall first be prepared as follows:
   1. Galvanized and black steel surfaces shall first be painted with one coat of galvanized metal primer.
   2. Aluminum surfaces shall first be painted with one coat of zinc chromate primer.

F. All ferrous metal surfaces without a protective finish and not galvanized in exposed and concealed areas including chases, under floor and above ceilings shall be painted with two coats of zinc chromate primer as the construction progresses to protect against deterioration.

G. All junction and pull boxes and covers which are part of raceway systems distributing emergency power shall be painted red. Where a multiple branch emergency power system is installed, the branch designation (LS, CB or EQ) shall be stenciled on the box cover in minimum one inch (1") high white letters.

H. All junction and pull boxes and covers and terminal cabinets which are part of the raceway/wiring system for fire alarm wiring shall be painted red. A system designation (FA) shall be stenciled on the box or cabinet cover in minimum one inch (1") high white letters.

I. [All conduit exposed to view shall be finish painted as directed by the Architect/Engineer.]
J. Before painting, all surfaces to be painted shall be suitably prepared. This shall include removing all oil, rust, scale, dirt, and other foreign material. Surfaces shall be made smooth by grinding, filing, brushing, or other approved method. In the painting operations, the primer for metal surfaces shall be of the zinc dust type unless specified otherwise, and where finish painting is specified, it shall be painted using materials and colors selected and approved by the Architect/Engineer. Refer to Division 9 for additional requirements.
PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions and Supplementary General Conditions, Division 1 General Requirements, and 26 00 01 Electrical General Provisions, apply to this section.

1.2 DESCRIPTION OF THE WORK:

A. General:

1. The Short Circuit Analysis, Protective Device Coordination Study and Arc Flash and Electrical Hazard Studies specified in this section shall be completed and submitted prior to submitting submittals for panelboards, enclosed circuit breakers and other electrical gear with short circuit or interrupting ratings.

2. The Electrical Contractor shall provide the Engineer with a Power System Short Circuit Analysis, Protective Device Coordination Study and Arc Flash and Electrical Hazard Study. These analysis’s and studies shall include all power distribution systems, beginning at the electric service point from the Electric Utility Company to the secondary buses of each panelboard as described hereafter.

3. The Short Circuit Analysis, Protective Device Coordination Study and Arc Flash and Electrical Hazard Studies shall be prepared by and certified with a registration seal and signature of a Registered Professional Engineer. The Engineer shall be qualified by experience in preparation of studies having similar requirements and of similar magnitude to that specified in this section of the Specifications.

4. The Short Circuit Analysis shall terminate at each branch bus at the lowest utilization voltage secondary bus where the symmetrical short circuit RMS amperes, total source plus all motor contribution, is less than 10,000 amperes for 208/240 volts and 14,000 amperes for 480 volts. It is the intent of these Specifications to determine all locations in the entire electrical system where the symmetrical short circuit amperes meets or exceeds 10,000 amperes at 208 volts and 14,000 amperes at 480 volts. The short circuit analysis shall compare interrupting rating of all installed electrical protective devices connected to each bus included in the study with that of the available fault current at the load terminals of each protective device. Appropriate recommendations shall be made for corrective action in the conclusions of the report where the interrupting rating of electrical equipment is exceeded by the available fault current.

5. The Protective Device Coordination Study shall start at the electric service and include all electrical distribution equipment protective devices with adjustable trip units, relay settings or options for fuse types. The curves and settings for the Power Company protective devices shall be included in the scope of this study.
The coordination plots shall terminate with the first non-adjustable overcurrent device or devices downstream of all protective devices with an adjustable trip unit, relay settings or options for fuse types. The protective device study shall include a separate analysis for phase and ground protection.

6. The Arc Flash and Electrical Hazard Study comply with applicable NEC and OSHA requirements and shall include calculating the Arc Flash and establishing the Electrical Hazard rating for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.

7. The Contractor shall obtain all lengths of cable from the electrical drawings and, where not shown the entire length of the run, from Contractor estimated lengths. All other equipment ratings shall be obtained by the Contractor from the equipment manufacturer's and/or suppliers.

B. Short Circuit Analysis: The Analysis shall include the following:

1. A schematic one-line drawing of the entire electrical system included in the study, from the power company system including the point of delivery, to each primary transformer, and including all main secondary buses of each transformer included in the study. Secondary buses shall include multiple secondary transformations within the scope of the study. Each device shall be identified using project assigned identification labels. Each motor 10 hp and larger shall be shown and identified. Each bus shall be assigned an identification number.

2. Source voltage and impedance data shall be given in the analysis, including reactance and resistance in OHMS to the source, and available symmetrical and asymmetrical short circuit amperes at the point of delivery of electrical power. Short circuit amperes shall be based on an assumed bolted 3 phase short circuit.

3. At each bus, including buses of all primary protective and switching devices, primary and secondary of all transformers, all secondary main and feeder breakers, and all secondary devices and panelboards within the scope of the study, the following shall be calculated for assumed bolted 3 phase short circuits.
   a. Symmetrical RMS short circuit amperes, calculated using total source and motor contribution reactance and resistance values.
   b. Asymmetrical average 3 phase RMS amperes at 1/2 cycle, calculated using actual total source and motor contribution X/R ratio.
   c. Reactance ("X") and Resistance ("R") in OHMS at the voltage of the device being examined, including both The Power Company source and all motor contributions.

4. Calculation sheets for cable sections shall indicate voltage, wire size, cable length, reactance and resistance of the section in OHMS and total "X" and "R" to the source.

5. Calculation sheets for transformer sections shall indicate transformer kVA, secondary voltage, percent impedance, percent reactance, percent resistance, and total "X" and "R" value in OHMS at the secondary voltage to source, including The Power Company source impedance plus any primary motor contribution.

6. Calculation sheets for busway and miscellaneous devices shall provide all pertinent parameters including operating voltage, section "X" and "R" values in OHMS, and total "X" and "R" values in OHMS to the source, based on source impedance plus any motor contribution.

7. Bus summary sheets shall be provided giving consecutive bus numbers, description, voltage, "X" and "R" values in OHMS including The Power Company...
plus all motor contributions, symmetrical and asymmetrical short circuit amperes, X/R ration, and asymmetrical factor.

8. Motor summary sheets shall provide motor description and all pertinent motor data including subtransient reactance for each motor 10 hp and larger. Symmetrical short circuit amperes shall be given for each motor at the motor terminals.

9. An evaluation of the adequacy of the short-circuit ratings of the electrical equipment supplied by that manufacturer. For this evaluation, circuit breakers shall all be fully rated.

10. All information shall be presented in a report form, signed and sealed by the engineer providing the analysis.

C. Protective Device Coordination Study: The Study shall include the following:

1. Time-current coordination plots shall be made on log-log sheets or equivalent software generated plots and shall graphically indicate the coordination proposed for all of the key systems. The plots shall include complete titles, one-line diagram and legend.

2. The Power Company’s relay, fuse, or protective device shall be plotted with all load protective devices at the same voltage.

3. Transformer primary protective device, transformer magnetic inrush, transformer ANSI withstand points, secondary voltage fuse or circuit breaker and largest feeder fuse or circuit breaker shall be plotted at the secondary voltage. Circuit breaker curves shall include complete operating bands, terminating with the appropriate available short circuit current. Fuse curves shall be identified as either total clearing time or damage time as applicable.

4. Low voltage circuit breakers shall have instantaneous, short delay, long-time pick-up and ground fault trip settings and ground fault ampere and time delay settings identified as plotted. Sensor or monitor rating shall be stated for each circuit breaker. All regions of the circuit breaker curve shall be identified.

5. The coordination plots shall include significant motor starting characteristics and large motor protective devices.

6. Feeder circuit breakers shall have the time-damage curve of the feeder conductors plotted to indicate protection of the conductor insulation at the total clearing time of the circuit breaker or fuse. This time-damage point shall be calculated for the specific parameters of conductor insulation used, with average 3 phase RMS asymmetrical amperes as 1/2 cycle calculated using actual resistance and reactance values of the source plus all motor contributions which exist at the load end of the feeder conductors. Conductor initial temperature and conductor maximum transient temperature for short circuits as recommended by ICEA shall be indicated.

7. High voltage relays shall have coil taps, time-dial settings and pick-up settings identified as plotted. Current transformer ratios shall be stated. Relays shall be separated by a 0.45 second time margin to assure proper selectivity where feasible. The relay operating curves shall be suitably terminated to reflect the actual maximum fault current sensed by the device.

8. A determination of settings or ratings for the overcurrent and ground fault protective devices supplied. Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection considered more important than service continuity. The time-current coordination analysis shall be performed with the aid appropriate software.
9. A summary tabulation shall be provided listing manufacturer and type for all overcurrent protective devices and all recommended settings of each adjustable band included in each device.

10. An evaluation of the degree of system protection and service continuity possible with the overcurrent devices supplied.

11. When main breaker is provided with setback to reduce the arc fault level both settings shall be included in the study.

12. All information shall be presented in a report form, signed and sealed by the Engineer providing the analysis.

D. **Arc Flash & Electrical Hazard Analysis**: The Analysis shall include the following:

1. The Arc-Flash & Electrical Hazard Analysis (AFEHA) shall be performed in accordance with the requirements of NFPA 70 Section 110.16, NESC ANSI C2-2007 Section 410.A.3, IEEE Std. 1584 and OSHA 29 CFR 1910.132(d) and 1910.335.

2. The AFEHA shall:
   a. Calculate incident energy levels and flash protection boundaries at all relevant equipment busses based on available short-circuit current, protective device clearing time and other applicable one-line diagram information.
   b. Calculate the Minimum Arc Fault Current, Arc Flash Boundary and Arc Flash Rating (cal/cm²) for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
   c. Identify the Arc Flash Hazard Category and risk of personnel injury as a result of exposure to incident energy released during an arc flash event for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
   d. Identify the current appropriate ratings of personal protective equipment (PPE) for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
   e. Establish the Flash Protection Boundary (approach limit distance) as required by NFPA 70E for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
   f. Provide equipment specific environment and chemical arc-flash hazard warning label requirements per NEC Section 110.16 for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project, including all information specified to be provided on individual equipment warning labels.
   g. Provide recommendations and methods to mitigate the hazard risk, where applicable, in order to reduce PPE requirements.
   h. All information shall be presented in a report form, signed and sealed by the engineer providing the analysis.

1.3 **STUDY AND ANALYSIS SEQUENCE**:

A. All studies and analysis specified herein shall be completed and submitted with electrical distribution equipment submittals to allow the Engineer to review submitted electrical
1.4 QUALITY ASSURANCE:
A. The short circuit analysis/coordination study shall be performed by the Engineering Department of the electrical equipment supplied for the project or by a qualified engineering consultant approved in writing in advance by the Engineer.

1.5 SUBMITTALS:
A. Shop Drawing submittals shall include, but not be limited to, the following:
1. Four copies of the Short-Circuit Analysis including, but not limited to:
   a. A printout of input data, calculated results and an explanation of how to interpret the data.
   b. A one-line diagram identifying all bus locations and the maximum available short-circuit current at each bus.
   c. A bus-to-bus listing of the maximum available short-circuit current expressed in RMS symmetrical amperes and the X over R ratio of that fault current.
   d. A table of specified equipment short-circuit ratings versus calculated short-circuit current values with notations of locations where are specified equipment short-circuit ratings are less or greater than required at the point of application.
   e. An analysis of the results in which any overrating or inadequacies shall be called to the attention of the Engineer and recommendations made for improvements.

2. Four copies of the Protective Device Coordination Study including, but not limited to:
   a. Time-current characteristic curve drawings on log-log printouts which illustrate:
      1) The recommended settings for all adjustable relays, overcurrent protective devices and ground fault protective devices provided for the project.
      2) The key or limiting overcurrent device characteristics, load characteristics, and protection requirements affecting the settings or ratings of the overcurrent protective devices supplied.
      3) The degree of service continuity and system protection achieved with the overcurrent protective devices supplied.
   b. A tabulation of the recommended settings for all adjustable relays, overcurrent protective devices and ground fault protective devices and type selections for fuse protective devices supplied.
   c. An analysis of the results in which any inadequacies related to selective coordination shall be called to the attention of the Engineer with recommendations for improved coordination.

3. Four copies of the arc-flash & electrical hazard analysis including, but not limited to:
   a. Minimum Arc Fault Current, Arc Flash Boundary and Arc Fault Rating (cal/cm²) for each switchboard, distribution panel, panelboard, automatic
transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.

b. Arc Flash Hazard Category and risk of personnel injury as a result of exposure to incident energy released during an arc flash event for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.

c. Current appropriate ratings of personal protective equipment (PPE) for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.

d. The Flash Protection Boundary (approach limit distance) as required by NFPA 70 for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.

e. Equipment specific environment and chemical arc-flash hazard warning label requirements per NEC Section 110.16 for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project, including all information specified to be provided on individual equipment warning labels.

f. Recommendations and methods to mitigate the hazard risk, where applicable, in order to reduce PPE requirements

4. Cut sheets and submittal information on the Arc Flash warning labels being provided.

5. Additional information as required in Section 260001, “Electrical General Provisions”.

PART 2 - PRODUCTS

2.1 ARC FLASH WARNING LABELS:
A. Labels: Seton Write-On Arc Flash Warning Labels or an approved equal labels with NEC and OSHA required warning information and with Arc Flash Hazard Category, minimum Personal Protection Equipment (PPE) required and Minimum Arc Rating (cal/cm²) clearly indicated.

PART 3 - EXECUTION

3.1 PROTECTIVE DEVICE SELECTION AND SETTING:
A. Settings and Selection: Prior to project Substantial Completion, the Contractor shall set all relays, overcurrent devices and ground fault protection devices and confirm selection of fuse overcurrent devices as follows:

1. Relays: Reset all adjustable relay settings from the factory default settings to the settings recommended in the studies specified in this section.

2. Circuit Breakers: Reset all adjustable trip settings from the factory default settings to the settings recommended in the studies specified in this section.

3. Ground Fault Protection Devices: Reset all adjustable device settings from the factory default settings to the settings recommended in the studies specified in this section.
4. Fuses: Confirm that fuse types installed on the project are as recommended in the studies specified in this section.

B. Certification: Prior to project Substantial Completion, the Contractor shall submit 4 signed copies of a document certifying that the Contractor has completed the settings and selection scope specified in Paragraph 3.1 A. to the Engineer.

3.2 AVAILABLE FAULT CURRENT LABEL:
A. Building Service entrance equipment shall be provided with a permanently affixed label listing the maximum available fault current at the time of installation and the date the fault current calculation was performed, per NEC 110.24. The label shall be 2” x 3” in size and shall be blue lettering on a contrasting background.

3.3 ARC FLASH WARNING LABELS:
A. Installation: Arc Flash warning labels shall be securely affixed to each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch in a readily visible location in accordance with NEC and OSHA requirements. The actual calculated Minimum Arc Rating (cal/cm²) for that individual piece of equipment along with the associated Arc Flash Hazard Category and minimum Personal Protection Equipment (PPE) required shall be clearly indicated on each warning label

END OF SECTION 260573
SECTION 26 09 26
LOW VOLTAGE LIGHTING CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions and Supplementary General Conditions, Division 1 General Requirements, and 26 00 01 Electrical General Provisions, apply to this section.

1.2 SECTION INCLUDES:

A. Work Included: The extent of low voltage lighting control work is as shown and scheduled, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications.

B. Types: The types of low voltage lighting control devices required for the project include, but are not limited to, the following:
   1. Digital Lighting Control Relay Panels
   2. Digital Room Controllers
   3. Digital Occupancy Sensors
   4. Digital Daylight Harvesting Photocells

C. Lighting Controls: Lighting control system shall utilize a programmable controller and mechanically-held relays to control lighting as shown on the drawings based on control inputs from the Building Automation System (BAS), via BACnet MSTP compatible network interface provided as part of the lighting control system, an internal astronomic timeclock and inputs from local lighting control override switches located as shown on the drawings.

1.3 QUALITY ASSURANCE:

A. Manufacturers: Low voltage control system shall be manufactured by WattStopper, Hubbell, Douglas Lighting Controls, nLight, Leviton, Eaton, Philips Lighting Controls or an equal listed on the drawings or approved by addenda prior to bid date. Manufacturer’s listed as equal will still be required to meet the specifications.

B. UL Standards: Products shall conform to all applicable UL standards and shall be UL-labeled.

C. Components: All components are to be supplied by same manufacturer.

1.4 SUBMITTALS:

A. Shop Drawings submittals shall include, but not be limited to, the following:
   1. Cut sheets on lighting control components.
   2. Wiring diagrams.
   3. Additional information as required in Section 260001, “Electrical General Provisions”.
   4. Line by line specification compliance.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver components in factory-fabricated water resistant packaging.

B. Handle components carefully to avoid damage to components, enclosures, and finish.

C. Store components in a clean, dry space and protect from weather.
PART 2 - MATERIALS

2.1 LIGHTING CONTROL PANELS

A. Provide lighting control panels in the locations and capacities as indicated on the plans and schedules. Each panel shall be of modular construction and consist of the following components:

1. Enclosure/Tub shall be NEMA 1, sized to accept an interior with 1 – 8 relays, 1 – 24 relays and 6 four-pole contactors, or 1 – 48 relays and 6 four-pole contactors.

2. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. The interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. The interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. The panel interiors shall include the following features:

   a. Removable, plug-in terminal blocks with screwless connections for all low voltage terminations.

   b. Individual terminal block, override pushbutton, and LED status light for each relay.

   c. Direct wired switch inputs associated with each relay and group channel shall support two-wire, momentary or maintained contact switches.

   d. Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches, digital IO modules capable of receiving 0-5V or 0-10V analog photocell inputs, digital IO modules capable of receiving momentary or maintained contact closure inputs, digital photocell modules, and digital occupancy sensors.

   e. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet.

   f. Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.

   g. Group, channel, and pattern control of relays shall be provided through a simple keypad interface from a handheld IR programmer. Any group of relays can be associated with a channel for direct on/off control or pattern (scene) control via a simple programming sequence using the relay and channel override pushbuttons and LED displays for channels 1-9 or a handheld IR programmer for channels 1-99.

   h. Relay group status for each channel shall be provided through red LED indicators for groups 1-9 and via BACnet for groups 1-99. Solid red indicates that the last group action called for an ON state and relays in the group are on or in a mixed state.

   i. Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:

   1) Electrical:

      a) 30 amp ballast at 277V
      b) 20 amp tungsten at 120V
      c) 1.5 HP motor at 120V
      d) 14,000 amp short circuit current rating (SCCR) at 347V
      e) Relays shall be specifically UL listed for control of plug loads

   2) Mechanical:

      a) Individually replaceable, ½” KO mounting with removable Class 2 wire harness.
      b) Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.
c) Dual line and load terminals each support two #14 – #12 solid or stranded conductors.

d) Tested to 300,000 mechanical on/off cycles.

(1) Isolated low voltage contacts provide for true relay status feedback and pilot light indication.

j. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.

k. Lighting control panels shall be WattStopper model LMCP8, LMCP24 or LMCP48 as shown on the plans or an equal listed on the drawings or approved by addenda prior to bid date.

2.2 BACnet® BASED DIGITAL COMMUNICATIONS

A. The lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices. Digital communications shall be RS485 master/slave token passing-based using the BACnet® protocol.

1. The panel shall have provision for an individual BACnet device ID. The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.

2. Lighting control relays shall be controllable as binary output objects in the instance range of 1 – 64. The state of each relay shall be readable and writable by the BAS via the object present value property.

3. The 99 channel groups associated with the panel shall be represented by binary value objects in the instance range of 201 – 299. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a channel group will put all relays associated with the channel into the normal-hours mode. Commanding 0 or NULL shall put the relays into the after-hours mode.

4. Setup and commissioning of the panel shall not require manufacturer-specific software or a computer. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the handheld IR programming remote. Provide BACnet objects for panel setup and control as follows:

a. Binary output objects in the instance range of 1 – 64 (one per relay) for on/off control of relays.

b. Binary value objects in the instance range of 1 – 99 (one per channel) for normal-hours/after-hours schedule control.

c. Binary input objects in the instance range of 1 – 64 (one per relay) for reading true on/off state of the relays.

d. Analog value objects in the instance range of 1 – 64 (one per relay) shall assign relays to channel groups in the range of 1 – 99.

e. Analog value objects in the instance range of 101 – 199 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute grace time period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches.

f. Analog value objects in the instance range of 201 – 299 (one per channel) shall assign an after-hours time delay value to the channel in the range of 1 – 240 minutes.
g. Multi-state value objects in the instance range of 1 – 99 (one per channel) shall provide the state of the relays assigned to the channel. Valid states shall be ALL ON, MIXED, BLINK, and ALL OFF.

5. The description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.

6. The BO and BV 1 – 99 objects shall support BACnet priority array with a relinquish default of off and after hours respectively. Prioritized writes to the channel BV objects shall propagate prioritized control to each member relay in a way analogous to the BACnet Channel object described in addendum aa. (http://www.bacnet.org/Addenda/Add-135-2010aa.pdf)

7. Panel-aggregate control of relay Force Off at priority 2 shall be available via a single BV5 object. Force On at priority 1 shall be available via a single BV4 object.

8. Lockout of all digital switch buttons connected to a given panel shall be commandable via a single BV2 object. The lock status of any connected switch station shall be represented as BV101-196.

9. Lighting control accessory devices connected to the panel shall be represented via BACnet objects including but not limited to the following:
   a. Digital occupancy sensor detection states shall be readable as BI objects ranging from BI1-96.
   b. Digital occupancy sensor configuration parameters shall each be accessible as BACnet objects when applicable to a given product.
      1) Occupancy sensor time delay in minutes shall be writeable via AV101-196.
      2) Occupancy sensor passive infrared (PIR) sensitivity percentage shall be writeable via AV201-296.
      3) Occupancy sensor ultrasonic (US) sensitivity percentage shall be writeable via AV301-396.
   c. Digital switch buttons shall be readable and writeable as BI objects ranging from BI101 – 9608.
   d. Digital daylight sensors foot-candle readings shall be readable as follows:
      1) Analog 0-5V/0-10V sensors connected to a digital input module shall be represented as AI1-96.
      2) Digital closed loop sensors shall be represented as AI4001-4096.
      3) Digital open loop sensors shall be represented as AI5001-5096.
      4) Digital dual loop sensors shall be represented as follows:
         a) The upward facing open loop sensor shall be represented as AI6001-6096.
         b) The downward facing closed loop sensor shall be represented as AI6101-6196.
   e. Digital daylight sensor configuration shall be exposed as BACnet objects as follows:
      1) Digital closed loop sensors shall be represented as follows:
         a) Daylight Sensor Day Setpoint (ftcd) AV4201-4296.
         b) Daylight Sensor Night Setpoint (ftcd) AV4301-4396.
         c) Daylight Sensor Off Setpoint Delay (minutes) AV4401-4496.
         d) Daylight Sensor On Setpoint (ftcd) AV4501-4596.
         e) Daylight Sensor Off Setpoint (ftcd) AV4601-4696.

2.3 USER INTERFACE

A. Each lighting control panel system shall be supplied with at least (1) handheld IR remote programming interface consisting of a keypad and associated OLED display screen. The user
interface shall allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer. The user interface shall have the following functions as a minimum:

1. Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.

2. Relay Group creation of up to 99 groups. Group creation shall result in programming of all seven key relay parameters for member relays. The seven parameters are as follows: After-hours Override Time Delay, Normal Hours Override Time Delay, Action on Transition to Normal Hours, Action on Transition to After Hours, Sensor Action During Normal Hours, Sensor Action During After Hours, Blink-Warn Time for After Hours.

3. Program up to 254 separate scheduled events. Events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays. Holidays are also defined through the User Interface.

4. Program up to 32 separate Dark/Light events. Events shall have a selectable source as either calculated Astro with delay, or a digital IO module with an integral 0-5V or 0-10V analog photocell. Dark/Light events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays.

5. Button binding of digital switches to groups shall be accessible via the handheld IR remote and accomplished from the digital switch station.

6. Programming of panel location information shall be accomplished by the handheld IR remote and include at a minimum LAT, LON, DST zone, and an approximate city/state location.

7. An additional handheld IR remote may optionally be specified to be permanently mounted to the panel interior via a retractable anti-theft lanyard to allow for convenient programming of the panel while assuring that the handheld programmer is always present at that panel. An unlimited number of handheld IR remotes may also be purchased for facilities staff as seen fit by the end user’s representative.

2.4 DIGITAL NETWORK SWITCHES

A. Provide digital wall switches with 1, 2, 3, 4, or 8 buttons, in the colors indicated on the plans. Switches shall connect to the panel via standard Cat 5e cable with RJ-45 terminations. Digital wall switches shall have the following features:

1. Available colors: white, ivory, light almond, grey or black.

2. Single gang device shall fit standard decorator opening and use standard wall plates.

3. LED indicator on each button for status and locator function.

4. Concealed configuration button with LED indicator for binding buttons to relays, no software or computer shall be required.

5. Infrared window for use with handheld two-way wireless configuration tool,

6. Selectable function mode per button shall be momentary toggle (on/off), on only, or off only.

7. Removable button assembly for field color change or substitution of engraved buttons.

8. Two RJ-45 ports for connection to panel or other switches and/or occupancy sensors.

9. Open topology digital network via Cat 5e wire.

10. Digital switches shall be WattStopper LMSW series as indicated on the plans.

11. Digital switch buttons shall be able to control groups and group actions shall be system global such that any digital switch station can affect the state of relays present in up to (12) twelve panels networked together via BACnet.
2.5 DIGITAL OCCUPANCY SENSORS

A. Provide digital occupancy sensors to control relays in locations as shown on the plans. Sensors shall be either passive infrared, ultrasonic, or dual technology as indicated. Sensors shall be either ceiling or wall mounded and connect to the panel using Cat 5e cable with RJ-45 terminations. Digital occupancy sensors shall have the following features:

1. Setup and calibration shall be digital and precisely repeatable from sensor to sensor.
2. User interface with pushbuttons and illuminated LCD screen for setup and calibration.
3. Ladder-free setup and calibration with optional handheld two-way infrared commissioning tool.
4. Sensitivity, 0 – 100% in 10% increments.
5. Time delay, 1 – 30 minutes in 1 minute increments.
6. Test mode with five-second time delay for simplified walk testing.
7. Digital occupancy sensors shall be WattStopper LM series as indicated on the plans.
8. Digital occupancy sensors shall be able to control groups and group actions shall be system global such that any digital occupancy sensor can affect the state of relays present in up to (12) twelve panels networked together via BACnet.

2.6 DIGITAL NETWORK CLOCK

A. Each panel shall include a digital clock capability able to issue system wide automation commands to up to (11) eleven other panels for a total of (12) twelve networked lighting control panels. The clock shall provide capability for up to 254 independent schedule events per panel for each of the ninety-nine system wide channel groups.

1. The clock capability of each panel shall support all of the energy saving features required of ASHRAE 90.1 - 2001, IECC 2003, as well as all state and local energy codes.
2. The clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and will include a battery back up for the clock function and EEPROM for program retention. Clocks that require multiple events to meet local code lighting shut off requirements shall not be allowed.
3. The clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours messages to automation groups that implement pre-configured control scenarios. Scenarios shall include:
   a. Scheduled ON / OFF
   b. Manual ON / Scheduled OFF
   c. Astro ON / OFF (or Photo ON / OFF)
   d. Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)
4. The user interface shall be a portable IR handheld remote control capable of programming any panel in the system.
5. The clock capability of each panel shall employ non-volatile memory and shall retain user programming and time for a minimum of 10 years.
6. Schedules programmed into the clock of any one panel shall be capable of executing panel local schedule or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost. Lighting control panels that are not capable of executing events independently of the global network shall not be acceptable.

2.7 APPLICATION SEQUENCE OF OPERATIONS SUPPORT

A. The lighting control panel shall support relay behavior parameter configuration of such an extent as to allow digital switch, digital occupancy sensor, digital automatic photocells, and scheduled events to seamlessly implement, at a minimum, the following operational sequences:
1. Title 24 or ASHRAE 90.1 2010 operation requiring Manual On 50%, Automatic on 100%,
automatic shut-off on vacancy shall be able to be implemented by using any two relays in a
given panel. The sensor(s) for that space will be bound to both relays, each of which shall
be given an independent operation mode of Auto On and Manual On respectively, such that
on occupancy only 50% of the lighting activates. The digital switch stations for the space,
having at minimum two buttons, shall be bound to both relays such that at least one button
controls only 50% of the lights and at least one separate button controls only the remaining
50% of the lights allowing for independent zone control. The occupancy sensor(s) action on
vacancy shall be to turn off both relays. Configuration of this operational sequence shall not
require special software or tools and shall be accomplished using only the handheld IR
remote control.

2. Open office spaces that must turn on automatically by sensor during the Normal Hours
operating period and stay on until a scheduled sweep of the space on transition to the After
Hours operating shall use the handheld IR remote control to create a group of the relays for
that space with a group parameter type that automatically adjust the Normal Hours and After
Hours run-time parameters to the required values. Relay operation during Normal Hours
shall therefore be for a relay to turn on when its respective occupancy sensor(s) detect
motion and to stay on until the After Hours sweep time. Once the After Hours sweep occurs,
all relays shall operate as automatic ON/OFF in response to their respective sensors.
Systems that require individual relay parameters to be adjusted on a per relay basis are not
acceptable.

3. Private office spaces that must operate as manual on/manual off during Normal Hours and
automatic on/automatic off during After Hours with no sweep off on transition to After Hours
operation shall use the handheld IR remote control to create a group of the relays that must
follow that operational sequence using a group parameter type that automatically adjusts the
Normal Hours and After Hours run-time parameters to the required values. Relay operation
during Normal Hours shall therefore be for a relay to turn on only when a digital switch
station button bound to it is activated and to turn off automatically in response to the
vacancy signal of all occupancy sensors bound to it. Systems that require individual relay
parameters to be adjusted on a per relay basis are not acceptable.

2.8 SCHEDULE, GROUP, AND PHOTOCELL CONTROL OF RELAYS

A. The lighting control panel shall support schedule, group, and photocell control functions via the
network as configured in the optional Segment Manager controller or building automation system.
The lighting control panel shall be fully compatible with building automation systems that are
BACnet compliant. See related specification sections for additional information on interfacing the
lighting control panel(s) to the building automation system.

PART 3 - INSTALLATION

3.1 INSTALLATION OF LOW VOLTAGE LIGHTING CONTROL:

A. General: Install low voltage lighting control devices where indicated, in accordance with
manufacturer's written instructions, applicable requirements of NEC, and recognized industry
practices to ensure that products serve intended function.

B. Box Condition: Install low voltage lighting control devices only in electrical boxes which are clean,
free from excess building materials, debris, and similar matter.

C. Cabinets: Relay component cabinets shall be neatly and securely installed plumb, surface-
mounted. Branch circuit connections shall be to relays as shown.

D. Low Voltage Wiring: All low voltage wiring shall be installed in conduit or a suitable raceway.
Refer to other sections of this specification for additional information on conductors, raceways
and related installation.
E. Line Voltage Wiring: All line voltage wiring shall be installed in conduit or a suitable raceway. Refer to other sections of this specification for additional information on conductors, raceways and related installation.

F. Color Coding: The complete low voltage wiring system shall be color coded according to manufacturer’s written instructions and conductors shall be identified or tagged at terminals.

3.2 BacNet Interface and Programming:
A. BACNet Interface: Coordinate the design, installation and programming of the lighting control system interface with the BAS with the Division 23 contractor.

B. Programming Input: The contractor shall obtain input from the Owner’s Project Manager and Electrical Engineer for all lighting control system features and settings prior to programming the lighting control system.

C. Programming: Program the lighting control system such that the system responds relays based on time program and override switch inputs, as shown and noted on the drawings, as specified herein and as directed by the Owner’s Project Manager.

3.3 TESTING:
A. General: Prior to energization, check continuity of circuits and short circuits. After energization, check low voltage lighting controls to demonstrate proper operation of all relays via the BacNet interface and by the local override switches.

B. Prior to final testing the selected manufacturer shall provide full setup and programming of all lighting control devices on the project to meet the intent of the drawings and these specifications.

3.4 FACTORY COMMISSIONING
A. Upon completion of the installation, the system shall be commissioned by the manufacturer’s factory authorized representative who will verify a complete fully functional system.

B. The factory commissioning shall include the following services. Programming of all button stations, configuration of all occupancy sensors and photocells. Verification of a complete and working system including MSTP network status. Provide written or computer-generated documentation on the commissioning of the system including room by room description including:

1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
2. Sequence of operation, (e.g. manual ON, Auto OFF, etc.)
3. Load Parameters (e.g. blink warning, etc.)

C. The electrical contractor shall request factory commissioning by submitting a startup request form at least (4) weeks before startup is required.

D. The electrical contractor shall provide at least (1) journeyman electrician, familiar with the installation of the system, dedicated to assisting the factory start-up technician for the entire duration of the commissioning process.

E. Upon completion of the system commissioning the factory-authorized technician shall provide the proper training to the owner’s personnel on the adjustment and maintenance of the system.

3.5 Re-commissioning – After 90 days from occupancy the factory authorized representative and electrical contractor shall re-calibrate all sensor time delays and sensitivities to meet the Owner’s Project Requirements. Provide a detailed report to the Architect / Owner of re-commissioning activity

END OF SECTION 260926
SECTION 26 22 00
LOW VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:
A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26 00 01, “Electrical General Provisions”, govern this Section.

1.2 DESCRIPTION OF WORK:
A. Work Included: Provide low voltage transformer work as shown, scheduled, indicated and as specified.
B. Types: The types of low voltage transformers required for the project include, but are not limited to,
   1. Dry- Type General Purpose Transformers.

1.3 STANDARDS:
A. Products shall be designed, manufactured, tested and installed in compliance with the following standards:
   1. NEMA ST 1 - Specialty Transformers.
   2. ANSI/NEMA ST 20 - Dry Type Transformers for General Applications.
   3. ANSI C33.4.
   4. ANSI C89.2.
   5. ANSI/UL 506 – Safety for Specialty Transformers.
   6. UL 1551 – Appliance Wiring Material.
   7. NEMA TP-1 and EPA Energy Star compliant.
B. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
C. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
D. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1.4 QUALITY ASSURANCE:
A. Listing and Labeling: Provide transformers specified in this Section that are listed by Underwriters Laboratories (UL), certified by CSA, bear the EPA ENERGY STAR logo. Transformers shall meet relevant NEMA, UL, CSA, NFPA, EPA Energy Star Program.
B. **Characteristics:** Transformer, with characteristics and options specified, must deliver the energy savings required under the EPA ENERGY STAR program and bear the EPA ENERGY STAR logo.

C. **Minimum Linear Load Efficiency:** NEMA TP-1 and EPA ENERGY STAR compliant; 97.5 percent for 30 kVA, 97.7 percent for 45kVA, 98.0 percent for 75 kVA, 98.2 percent for 112.5kVA, 98.3 percent for 150 kVA, 98.5 percent for 225 kVA, 98.6 percent for 300 kVA, 98.7 percent for 500 kVA.

D. **Non-linear Load Efficiency:** Greater than 98 percent for all transformers 45kVA and above, greater than 97 percent for transformers 30kVA and smaller. Load per section “Factory Test Reports” above.

E. **Manufacturers:** Provide products complying with these specifications and produced by one of the following:
   
   1. Dry-Type General Purpose.  
      c. Square D Company.  
      d. Cuttler Hammer - Eaton.  
      e. Siemens.  
      f. Power Smith.

F. **Energy Star:** Manufacturer must be a US Environmental Protection Agency (EPA) ENERGY STAR Partner.

G. **UL Label:** All transformers shall be UL-labeled.

1.5 **SUBMITTALS:**

A. Shop Drawing submittals shall include, but not be limited to, the following:

   1. Include data on features, components, ratings and performance for each type of transformer specified. Include dimensioned plans, sections, and elevation views. Show minimum clearances and installed devices and features.
      
      a. Include outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics.
      
      b. No load core loss, full load winding conductor loss, full load losses, efficiency at 25 percent, 50 percent, 75 percent and 100 percent rated loads, percent regulation with 80 percent and 100 percent power factor loads, sound level, tap configurations, insulation system type and rated temperature rise.

   2. Cut sheets of the transformers with load ratings, sound ratings, and all associated accessories clearly indicated.

   3. Include outline and support point dimensions of enclosures and accessories; unit weight; voltage; kVA; impedance ratings and characteristics; loss data; efficiency at 25, 50, 75
and 100% rated load; sound level; tap configurations; insulation system type, and rated temperature rise.

4. Additional information as required in Section 26 00 01, “Electrical General Provisions”.

5. Wiring Diagrams: Detail wiring and identify terminals for tap changing and connecting field-installed wiring.

6. Product Certificates: Signed by manufacturer of transformers certifying that the products furnished comply with requirements, including harmonic performance guarantee.

7. Factory Test Reports: Base data for electrical characteristics on actual laboratory tests of typical transformers for harmonic performance and energy efficiency. Testing to be conducted using three (3) single-phase 120V nonlinear load banks with personal computer harmonic profile (100 percent current THD) at 35 percent or more of transformer nameplate load level. Test results to be submitted at time of quotation to include transformer efficiency, change in voltage THD between transformer primary and secondary terminals, ratio of 3rd harmonic current in primary delta current profile compared to that in secondary phase current.

8. Copies of manufacturer’s design and routine factory tests required by referenced standards, including results of zero sequence impedance and reactance tests.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING:

A. Transport, handle, store and protect products.

B. Deliver transformers individually wrapped for protection and mounted on shipping skids.

C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle transformers carefully to avoid damage to material components, enclosure and finish. Use only lifting eyes and brackets provided for that purpose. Damaged transformers shall be rejected and not be installed on project.

E. Store transformers in a clean and dry space and protect from weather. Do not stack transformers.

F. Apply temporary heat according to manufacturer’s written instructions within the enclosure of each ventilated-type unit throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.

G. Transformers shall not be used as work tables, scaffolds or ladders.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

A. General: Except as otherwise indicated, provide transformer manufacturer's standard materials and components as indicated by his published product information, designed and constructed as recommended by the manufacturer, and as required for a complete installation.
2.2 DRY TYPE GENERAL PURPOSE, K-RATED AND ISOLATION TRANSFORMERS:

A. General:

1. Indoor transformers shall be dry type, 2-winding transformers, voltage, phase and kVA rated as shown, noted or scheduled. Transformers shall be designed for 60-hertz operation, self-cooled per NEMA Class AA and shall have manufacturer's standard impedance.

2. Primary winding of 3-phase standard transformers shall be delta-connected. Secondary windings of 3-phase transformers shall be wye or as required to cancel zero sequence current flux for phase cancellation type, with the common neutral brought out. Transformer primary and secondary voltages shall be as shown on the Drawings.

3. Suppression transformers shall have the primary and secondary coils physically separated.

B. Construction:

1. Transformer core shall be of a common core construction using cold rolled, oriented, high permeability silicon steel, formed as a coil. Windings shall be copper individual windings terminated with tin-plated or silver-plated copper bars or wire electrically welded to the ends of the windings. Foil windings shall not be acceptable.

2. Transformer coils shall be vacuum pressure impregnated (VPI) with non-hydroscopic, thermosetting varnish and shall have a final wrap of electrical insulating material designed to prevent injury to the magnet wire. Transformers having coils with magnet wire visible will not be acceptable. The core and coil shall be completely isolated from the enclosure by means of vibration absorbing mounts.

3. All ventilating openings shall be of the baffled type. Ventilated dry-type transformers installed in sprinklered space shall have rain shields on all openings.

4. The base of the transformer shall be constructed of heavy gauge steel. The transformer enclosure shall be degreased, cleaned, phosphatized, primed, and finished with baked enamel.

C. Taps: Transformers shall have taps as follows:

<table>
<thead>
<tr>
<th>KVA Rating</th>
<th>Taps</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25 to 2 kVA, single phase</td>
<td>No taps</td>
</tr>
<tr>
<td>3-15 kVA, single phase</td>
<td>Two 2.5% taps below normal voltage</td>
</tr>
<tr>
<td>25-100 kVA, single phase</td>
<td>Six 2-1/2% taps, two above and four below normal voltage</td>
</tr>
<tr>
<td>167-250kVA, single phase</td>
<td>Four 2-1/2% taps, two above and two below normal voltage</td>
</tr>
<tr>
<td>9-15 kVA, three phase</td>
<td>Two 2.5% taps below normal</td>
</tr>
<tr>
<td>30-300 kVA, three phase</td>
<td>Six 2-1/2% taps, two above and four below normal voltage</td>
</tr>
</tbody>
</table>
D. Temperature Rating: Transformers shall utilize an insulation system that has been properly temperature classified and approved by UL and shall have temperature ratings as follows. The maximum top of case temperature shall not exceed 50°F (standard and K Factor rated designs) rise above ambient.

<table>
<thead>
<tr>
<th>KVA Rating</th>
<th>Temperature Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25 to 2 kVA</td>
<td>Maximum winding temperature rise of 80°C with an insulation system temperature classification of 155°C</td>
</tr>
<tr>
<td>3-9 kVA</td>
<td>Maximum winding temperature rise of 115°C with an insulation system temperature classification of 185°C</td>
</tr>
<tr>
<td>15 kVA and above</td>
<td>Maximum winding temperature rise of 150°C with an insulation system temperature classification of 220°C</td>
</tr>
</tbody>
</table>

E. K-Factor Non-Linear Load Ratings: Transformers, where shown on the drawings, shall be K Factor rated to serve non-linear loads. Transformer primary and secondary temperature shall not exceed 220°C at any point in the coils while carrying the transformer full rated capacity of non-linear loads at the load K Factor shown on the drawings.

F. K-Factor Rated Transformer Neutrals: Neutral terminals for phase cancellation K Factor rated transformers shall be designed for 200 percent of the secondary phase conductor ampacity.

G. Load Rating:
   1. Transformers shall be capable of operating at 100% of nameplate rating continuously while in an ambient temperature not exceeding 40°C.
   2. Transformers 5 kVA and larger shall be capable of meeting the daily overload requirements of ANSI Standard C57.12.

H. Vibration Isolation: Each transformer core and coil shall be mounted in the transformer enclosure on rubber vibration isolators. Vibration isolators shall limit the transmission of sound from the 120 Hz harmonic to 10% of its unisolated level, and shall certified as such on the Shop Drawings.

I. Grounding: The core and coils shall be visibly grounded to the frame of the transformer cubicle by means of a flexible grounding strap of adequate size.

J. Sound Rating: The transformer shall have sound levels equal to or lower than those ratings established in the latest revision of NEMA ST-20 and as shown in the following table. Sound ratings shall be measured per ANSI C89.91.
K. Testing:

1. The manufacturer shall have thoroughly tested each transformer for proper operation before shipment.

2. The manufacturer shall have performed the following additional tests on units identical to the design type being supplied. Furnish proof-of-performance of these tests in the form of test data sheets upon request.
   a. Sound levels.
   b. Temperature rise tests.
   c. Full-load core and winding losses.
   d. Percent regulation with 80 and 100% power factor load.
   e. Percent impedance.
   f. Exciting current.
   g. Insulation resistance.
   h. Efficiency at 1/4, 1/2, 3/4, and full load.
   i. Noise attenuation on suppression transformers.

L. Shield: Provide an electrostatic shield between the transformer primary and secondary to attenuate source side line interference for transformers indicated to be shielded and for all transformers with a K-factor rating greater than 1.0.

PART 3 - EXECUTION

3.1 INSTALLATION OF TRANSFORMERS:

A. General: Install transformers as indicated in accordance with the applicable requirements of the NEC and the National Electrical Contractor’s Association “Standard of Installation”. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. Manufacturer’s Recommendations: All installation shall be in accordance with manufacturer’s published recommendations.

C. Conduit Connections: All conduit directly connected to transformer enclosures shall be flexible steel conduit extending for a minimum of 24 inches from transformer enclosure as
measured along the conduit center line. Run a bonding jumper, sized per NEC Table 250-95, on outside of flexible conduit.

D. **Cable Connections**: Make transformer cable connections with compression-type lugs suitable for termination of 75 degrees C rated conductors. Position lugs so that field connections and wiring will not be exposed to temperature above 75 degrees C.

E. **Housekeeping Pads**: All floor standing transformers shall be provided with a nominal reinforced concrete housekeeping pad. Refer to Section 26 05 01, "Electrical Basic Materials and Methods", for additional requirements.

F. **Transformer Isolation**: Install floor-mounted transformers on concrete housekeeping pads with vibration isolating pads suitable for isolating the transformer noise from the building structure in accordance with Section 26 05 01, "Electrical Basic Materials and Methods". Maintain a minimum of six (6) inches free air space between enclosure and walls.

1. Install transformer plumb and level.
2. For floor and trapeze transformer installations, use one pad type Korfund Elasto-Grip, waffle at each corner of the transformer, sized for load of 50 pounds per square inch.
3. For wall hung transformer installations (15kVA and less), use spring type Korfund Series P. Provide sound pads at each corner of the transformer sized for ½ inch deflection. Securely anchor wall-mounting brackets to wall to provide adequate support.

G. **Suspended Transformers**: Suspend transformers (45kVA and less) from structure by means of trapeze hangers constructed of ½ inch galvanized all-thread rods and metal framing channels. Make double-nut connections between rods and channels. Locate transformers to provide adequate ventilation and accessibility.

H. **Identification**: Refer to Section 26 05 53, “Identifications for Electrical Systems”, for transformer identification.

3.2 **TESTING**:

A. **Pre-Energization Check**: Check for damage and tighten connections prior to energizing transformer. Verify removal of coil shipping anchor bolts before transformer is energized.

B. **Insulation Tests**: Prior to energization, check transformer windings for continuity. Test the insulation resistance from primary phase winding to winding, primary winding to secondary winding, secondary phase winding to winding, and from each winding to ground. Tests shall be made with a Biddle Megger or equivalent test instrument at a voltage of not less than 1000 volts dc with readings taken after 30 and 60 seconds of operation at Megger slip speed. Transformers which do not meet or exceed manufacturer’s winding insulation resistance specifications shall be replaced and the new transformer shall be tested, until an acceptable resistance is obtained.

C. **Winding Current**: During initial no-load energization, check current in each primary winding.

D. **Tap Settings**: Measure and record load current and voltage of transformers while loaded to verify proper transformer tap setting. Select the appropriate tap setting on transformer so that the actual secondary voltage is + 1/2 of a tap span at full load.
E. **Test Submittals:** Contractor shall furnish all instruments and personnel required for tests. Submit four copies of certified test results to Architect for review. Reports shall include transformer tested, date and time of tests, serial number, tap setting, input and output voltages, primary and secondary winding currents, insulation test results, manufacturers winding insulation resistance specifications, relative humidity, temperature, and weather conditions.

F. **Notification:** Notify Architect in writing of any deviation from manufacturer's pre-shipment test data.

**END OF SECTION 26 22 00**

E&C Engineers & Consultants Inc.
TX Firm Registration No. F-003068
SECTION 262416

PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions and Supplementary General Conditions, Division 1 General Requirements, and 26 00 01 Electrical General Provisions, apply to this section.

1.2 DESCRIPTION OF WORK:
   A. Work Included: Provide panelboard and enclosure work, including cabinets, as shown, scheduled, indicated, and as specified.
   B. Types: The types of panelboards and enclosures required for the project include, but are not limited to, the following:
       1. Power distribution panelboards.
       2. Lighting and appliance panelboards.

1.3 STANDARDS:
   A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:
       1. NEMA AB 1 Molded Case Circuit Breakers.
       2. NEMA KS 1 Enclosed Switches.
       3. NEMA PB 1 Panelboards.
       4. NEMA PB 1.1 Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

1.4 QUALITY ASSURANCE:
   A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
       2. General Electric Company.
       4. Siemens.
   B. UL Standards: Panelboards and enclosures shall conform to all applicable UL standards and shall be UL-labeled.

1.5 SUBMITTALS:
   A. Shop Drawing submittals shall include, but not be limited to, the following:
       1. Cut sheets of the circuit breaker and fusible switch distribution panels and panelboards with construction, fuse and circuit breaker amperage and poles, interrupting ratings, and quantities clearly listed, and with bus amperage, voltage, phase and wires, integrated equipment ratings and all associated accessories clearly indicated.
2. Include dimensioned drawings of panelboards and enclosures. Submit, if requested, transparencies of circuit breaker characteristics with unlatch times and fuse characteristics with melting/clearing times.

3. The Short Circuit Analysis, Protective Device Coordination Study and Arc Flash and Electrical Hazard Studies specified in Section 260573, “Short Circuit Analysis/Coordination Study” shall be completed and submitted prior to submitting submittals for this section.

4. Additional information as required in Section 260001, “Electrical General Provisions”.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver distribution panels and panelboards in factory-fabricated water-resistant wrapping.

B. Handle panelboards carefully to avoid damage to material component, enclosure and finish.

C. Store distribution panels and panelboards in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

A. **General**: Lighting and appliance panelboards shall be dead front safety type equipped with molded case circuit breakers as shown and scheduled. Power distribution panelboards shall be dead front type equipped with fusible switches or circuit breakers as shown and scheduled.

B. **Busing Assembly**: Panelboard and power distribution panel board busing shall be **tin or silver-plated copper**. Bus structure and mains shall have ratings as shown and scheduled and shall be phase sequence construction. Such ratings shall be established by heat rise tests with maximum hot spot temperature on any connector or busbar not to exceed 65°C rise above 40°C ambient. Heat rise test shall be conducted in accordance with UL 67. The use of conductor dimensions will not be accepted instead of actual heat tests. All bus joints shall be bolted with medium carbon steel, zinc or cadmium plated hardware equipped with lock washers and torqued to the manufacturer’s recommended settings (usually ASTM standards). All bolted connections shall have Belleville washers. Furnish a bare uninsulated or an isolated, where noted, ground bus inside each 208Y/120 volt panelboard enclosure and elsewhere where noted on the Drawings. Furnish an isolated full size neutral bus, insulated where noted, in all panels where the neutral is present. All multi-section panelboards shall be connected with copper cable, with an ampacity meeting or exceeding the main bus ampacity. All distribution and 120/208 volt panels shall have a ground bus. All 277/480 volt panels shall have a ground bus where a ground wire is shown in the panel feeder or branch circuits.

C. **Neutrals**: All panels serve by K-rated or phase cancellation transformers shall have 200% rated neutral.

D. **Molded Case Circuit Breakers**:  

   1. Circuit breakers shall be of the molded case, thermal magnetic type equipped with individually insulated, braced and protected connectors. The front faces of
all circuit breakers shall be flush with each other. Tripped indication shall be clearly shown by the breaker handle taking a position between "ON" and "OFF". Provisions for additional breakers shall be such that no additional connectors will be required to add breakers. Circuit breakers shall bolt in to the main bus for 480/277 volt panels (except Square D I-line panels which shall have plug-in breakers) and bolt on to the main bus for 208/120 volt panels. All 2 and 3-pole breakers shall have common trips. Where "series rated" breakers are shown, scheduled or specified and the manufacturer does not have a series rated breaker combination for the application shown, fully rated breakers with the required minimum interrupting capacity shall be provided.

2. All single-pole circuit breakers shall be either ambient or case-compensated (calibrated 40°C) thermal-magnetic type breakers, with inverse time delay on overloads and instantaneous magnetic trip on short circuits. (Twin, tandem and half-size single-pole breakers and breaker tie handles are not acceptable.) All multiple breakers shall be common trip, thermal-magnetic type, calibrated 40°C.

3. The breakers shall employ quick-make, toggle mechanism for manual operation, as well as automatic operation. The breakers shall have provisions for manually testing the tripping mechanism with the breaker removed from the panel. Automatic tripping shall be indicated by the breaker handle assuming a clearly distinctive position from the manual "on" and "off" positions.

4. Circuit breakers used as switches in 120 volt and 277 volt fluorescent lighting circuits, the circuit breakers shall be approved for such switching duty and shall be marked "SWD".

5. Provide panelboard circuit breakers with conventional interrupting capacity unless scheduled shown or noted otherwise, but in no case less than the following symmetrical amperes RMS:

<table>
<thead>
<tr>
<th>Voltage (volts)</th>
<th>Interrupting Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>120/208</td>
<td>10,000 AIC</td>
</tr>
<tr>
<td>277/480</td>
<td>14,000 AIC</td>
</tr>
</tbody>
</table>

6. Provide distribution panel circuit breakers with conventional interrupting capacity unless scheduled shown or noted otherwise, but in no case less than the following symmetrical amperes RMS:

<table>
<thead>
<tr>
<th>Frame Size/Voltage (volts)</th>
<th>Interrupting Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>100AF to 225AF/240V</td>
<td>10,000 AIC</td>
</tr>
<tr>
<td>400AF to 1000AF/240V</td>
<td>42,000 AIC</td>
</tr>
<tr>
<td>1200AF/240V</td>
<td>100,000 AIC-</td>
</tr>
<tr>
<td>100AF/480V</td>
<td>18,000 AIC</td>
</tr>
<tr>
<td>225AF/480V</td>
<td>25,000 AIC</td>
</tr>
<tr>
<td>400AF to 1000AF/480V</td>
<td>30,000 AIC</td>
</tr>
<tr>
<td>1200AF/480V</td>
<td>50,000 AIC</td>
</tr>
</tbody>
</table>

7. Current limiting thermal-magnetic circuit breakers suitable for interrupting currents up to 200,000 amperes shall be provided where scheduled or specified. Current limiting breakers shall have a non-fusible type independently operating limiter section in series with each pole which shall automatically reset after circuit interruption. Current limiting circuit breakers shall be equal to Square D Company "I-LIMITER".

8. Ground fault interrupter (GFI) circuit breakers, where shown, shall be 5 ma ground fault trip and shall include a TEST button.
9. Distribution panel circuit breakers **400 ampere frame and above** shall be equipped with solid-state programmable trip complete with built-in current transformers, solid-state trip unit and flux transfer shunt trip. The solid-state electronic programmable trip device shall have the following features and tripping functions.

   a. Adjustable current setting.
   b. Adjustable long-time delay.
   c. Adjustable instantaneous pick-up.
   d. Adjustable short time delay.
   e. Adjustable short time pick-up.
   f. [Adjustable ground fault delay]
   g. [Adjustable ground fault pick-up]

E. **Fusible Switches**: Fusible switches shall be quick-make quick-break type. Each switch shall be enclosed in a separate steel enclosure. The enclosure shall employ a hinged cover for access to the fuses. Cover shall be interlocked with the operating handle to prevent opening the cover when the switch is in the "ON" position. This interlock shall be constructed so that it can be over-ridden for testing fuses without interrupting service. The switches shall have padlocking provisions in the "OFF" position. Switches shall include positive pressure rejection type fuse clips for use with UL Class R fuses and be UL-labeled for 200,000 AIC.

F. **Lugs**: Panelboards and distribution panels shall be provided with main lugs, main overcurrent devices, and feed-thru lugs as noted on the Drawings. Lugs shall be suitable for use with the cable size and material installed. Panel wireways shall provide adequate space for wiring to all lugs.

G. **Spaces**: Where space for future breakers is shown, panelboard enclosure shall include removable blank panels or knockouts to allow installation of future breakers and panelboard busing shall be complete, including all required connectors.

H. **Integrated Equipment Rating**: Each panelboard, as a complete unit, shall have short circuit bracing and a short-circuit rating equal to the interrupting rating of the weakest overcurrent device installed in the panelboard. This rating shall equal or exceed the rating shown, scheduled or noted on the Drawings. Such ratings shall have been established by tests on similar panelboards with the circuit breakers installed.

I. **Short Circuit Bracing**: Distribution panel bussing shall have short circuit bracing as shown, scheduled or noted on the drawings and this rating shall be clearly indicated on the distribution panel nameplate.

J. **Panelboard Enclosures**: Panelboard enclosures shall be code gauge galvanized steel with wire bending space per the NEC. Panelboard enclosures shall be NEMA Type 1 surface or flush mounted as shown, scheduled or noted for indoor locations and NEMA 3R for outdoor locations, minimum 16 gauge thickness, minimum 20" width, with multiple knockouts, unless shown, scheduled or noted otherwise. Panelboard fronts shall be full-height hinged door-in-door front covers with an interior access door hinged to the front cover providing dead-front access to the panelboard overcurrent devices (interior) and the dead front main cover over the interior and wireway full-height hinged to the panelboard back box with fastening, concealed on flush mounted panelboards, on the non-hinged side. Provide flush spring latch and keyed lock for all panelboard access doors with all distribution panel and panelboard locks keyed alike. Provide an interior circuit directory frame, card and clear plastic covering inside the interior access door for all lighting and appliance panelboards. Door and cover trim shall be painted with manufacturers standard gray enamel finish over a rust inhibitor. Trim on flush mounted
panels shall have concealed fasteners. Enclosures shall be fabricated by the same manufacturer as panelboards to be enclosed. Multi-section panelboards shall have separate covers and trims. Multi-section panel cans shall be installed side by side with covers butted together.

K. Distribution Panel Enclosures: Distribution panel enclosures shall be code gauge galvanized steel with wire bending space per the NEC. Distribution panel enclosures shall be NEMA 1 surface or flush mounted as shown, scheduled or noted for indoor locations and NEMA 3R for outdoor locations. The distribution panel interior assembly shall be dead front with panel front removed. Main lugs or main circuit breakers shall have barriers on five sides. The barrier in front of the main lugs shall be hinged to a fixed part of the interior. The end of the bus structure opposite the mains shall have barriers. Interior surface distribution panels shall have full height front covers full height hinged to the distribution panel back box with fastening on the non-hinged side. Interior flush and exterior distribution panel fronts shall be full-height hinged door-in-door front covers with an interior access door hinged to the main front cover providing dead-front access to the panelboard overcurrent devices (interior) and the dead front main cover over the interior and wireway full-height hinged to the panelboard back box with concealed fastening on the non-hinged side. Cabinet interior doors shall be equipped with a latch and tumbler type lock. Doors over 48" long shall be equipped with a three point latch and vault lock with all distribution panel and panelboard locks keyed alike. Cabinets shall be of sufficient size to allow a width of gutter to conform with Underwriters' Laboratories, Inc. Standards. Panel trim shall be full finish sheet steel finished with two coats of paint, the first being a prime coat and the second a finish coat of light gray lacquer.

PART 3 - EXECUTION

3.1 INSTALLATION OF PANELBOARDS AND ENCLOSURES:

A. General: Install panelboards and enclosures as shown, including electrical connections, in accordance with the manufacturer's written instructions, the applicable requirements of NEC, the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended function.

B. Coordination: Coordinate installation of panelboards and enclosures with cable and raceways installation work. Verify that wall thickness is adequate where recessed panels are shown.

C. Anchoring: Anchor enclosures firmly to walls and structural surfaces ensuring that they are permanently and mechanically secured.

D. Concrete Pads: Install each floor-mounted power distribution panelboard on a reinforced concrete housekeeping pad. The housekeeping pad shall extend 3" beyond the housing of the distribution panel, unless otherwise shown. Furnish the exact position of any block outs, dimensions, and location of the housekeeping pads in time to prevent delay of the concrete work. Refer to Section 260501, "Electrical Basic Materials and Methods", for additional requirements.

E. Directory Card: Type the enclosure's circuit directory card upon completion of work. Refer to Section 260553, "Identification for Electrical Systems", for additional requirements.

F. Fuses: Install fuses, of the rating and class shown, in each power distribution and motor control panelboards.

G. Circuit Arrangement: Branch circuit connections to 3-phase lighting and appliance panelboards shall be arranged such that when two or three circuits are run with a
common neutral, each circuit shall be connected to a different phase unless otherwise shown. At the completion of the electrical system this Contractor shall check each phase of all panels under full load and arrange so that all phases shall carry the same load as near as possible.

H. Spare Conduits: Stub three empty one inch (1") conduits to accessible location above ceiling out of each recessed panelboard.

3.2 TESTING:
A. **General:** Prior to energization, check for continuity of circuits and for short circuits.

B. **Thermographic Testing:** Refer to Section 260125, "Electrical Testing", for thermographic testing.

3.3 IDENTIFICATION:
A. **Identification:** Refer to Section 260553, "Identification for Electrical Systems", for applicable painting, nameplates, and labeling requirements.

END OF SECTION 262416
SECTION 262701

ELECTRICAL SERVICE ENTRANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions and Supplementary General Conditions, Division 1 General Requirements, and 2600 01 Electrical General Provisions, apply to this section.

1.2 DESCRIPTION OF WORK:
A. General: The electrical service shall be at 240/120 volts, 2-phase, 3-wire, 60 Hz, and shall be obtained from AEP hereafter called "The Power Company".

B. Power Company Data: Obtain from The Power Company all required information and installation standards to furnish a complete electrical service installation and make all arrangements required to obtain electrical service.

C. Responsibilities: Division 26 shall be responsible for determining which equipment and labor is by The Power Company, which is by Division 26, and shall be responsible for any charges by The Power Company for service installation. Make all arrangements necessary to obtain electrical service from The Power Company. Obtain all necessary standards and detail drawings from The Power Company before construction of service equipment is commenced. The Power Company service data as shown is accurate as determined on the date of Specification issue and shall be verified as specified hereinabove. All materials, construction, and methods of installation of service equipment shall comply with The Power Company requirements, including, but not limited to: Primary conduits and ductbanks, transformer pads/provisions, concrete equipment pads, metering conduit, grounding system, and instrument transformer cabinets. Service equipment shall be grounded per the National Electrical Code (NEC) and as indicated on the Drawings and in the Specifications.

D. Utility Service Equipment: Service for the building will be available from a pad mounted transformer by The Power Company. Service metering shall be installed as required by the power company.

1.3 SUBMITTALS:
A. Shop Drawings submittals shall include, but not be limited to, the following:
   1. Dimensioned drawing showing exact provisions for service.
   2. Additional information as required in Section 260001, "Electrical General Provisions".

PART 2 - PRODUCTS

2.1 GENERAL:
A. Service Data: The Power Company service data is accurate as determined on the date of Specification issue and shall be verified as described in Paragraph 1.2, hereinabove.

2.2 PRIMARY SERVICE:
A. General: Division 26 shall provide primary service ductbank and manholes as shown and as specified in Section 260533, "Electrical Raceways", and Section 260534, "Electrical Boxes".

B. Power Company: The Power Company shall provide primary cables, splices, terminations, and primary overhead service lines.

C. Approval: The Power Company shall approve the underground primary conduit installation prior to concrete encasement.

2.3 TRANSFORMERS AND SWITCHGEAR:

A. General: Division 26 shall provide all necessary provisions for service as required by The Power Company, including, but not limited to, grounding rods, grounding conductors, and sleeves.

B. Power Company: The Power Company shall provide pad mounted transformers, primary switchgear, protective relaying and connections to the customer service cables.

2.4 SECONDARY SERVICE CABLE:

A. General: Division 26 shall provide secondary service cables as shown for connection to the service transformer.

2.5 METERING EQUIPMENT AND PROVISIONS:

A. General: Division 26 shall provide metering conduits and metering provisions as shown and as directed by The Power Company.

B. Power Company: The Power Company shall provide metering equipment, metering cans and interconnecting wiring.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Standards: The complete installation of the service entrance provisions shall comply with the standards and requirements of The Power Company and with requirements of other Sections of this Division.

B. Correction: Any failure to meet these standards and requirements shall be corrected to the satisfaction of The Power Company without any additional cost to the Owner.
SECTIONS 262717
EQUIPMENT WIRING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including TPWD’s Uniform General
   Conditions and Supplementary General Conditions, Division 1 General Requirements,
   and 26 00 01 Electrical General Provisions, apply to this section.

1.2 DESCRIPTION OF WORK:
   A. Work Included: The extent of electrical connections for equipment is as shown and
   scheduled, as indicated by the requirements of this Section, and as specified elsewhere
   in these Specifications.
   B. Types: The types of electrical connections required for the project include, but are not
   limited to, the following:
   1. Motors and equipment power connections.
   2. Contractor and Owner-furnished equipment power connections.
   3. Miscellaneous control power connections.
   4. Other equipment requiring power connections.
   C. Work of Other Sections:
   1. Refer to other Divisions of these Specifications for specific individual equipment
   electrical requirements.

1.3 QUALITY ASSURANCE:
   A. Manufacturers: Provide products complying with these specifications and produced by
   one of the following:
   1. AMP, Inc.
   2. Burndy Corporation.
   3. Cadweld.
   4. O. Z. Gedney Company.
   5. General Electric Company.
   6. Ideal Industries, Inc.
   7. Mac Products, Inc.
   B. UL Label: All products shall be UL-labeled to the maximum extent possible.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:
   A. General: For each electrical connection indicated, provide a complete assembly of
   materials, including, but not necessarily limited to, pressure connectors, terminals (lugs),
   etc.
electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other items and accessories as needed to complete splices and terminations.

B. Raceways: Refer to Section 260533, "Electrical Raceways", and Section 260534, "Electrical Boxes".

C. Cable, Wire, and Connectors: Refer to Section 260519, "Low Voltage Conductors and Cables".

D. Motor Starters and Safety Switches: Section 262818, "Enclosed Switches".

E. Terminals: Provide electrical terminals as instructed by the terminal manufacturer for the intended application.

PART 3 - EXECUTION

3.1 MOTOR AND EQUIPMENT POWER CONNECTIONS:

A. All power connections to motors and equipment furnished by other Divisions shall be made by this Division unless noted otherwise on the Drawings. This Division shall provide and install all power wiring and shall make all final connections.

B. Refer to the Drawings, approved Shop Drawings and other applicable Divisions for required power connections to equipment and motors.

C. All motorized or electrically operated equipment will be set in place by the furnishing Division with all integrally mounted starters, controls and disconnect switches installed. The furnishing Division will furnish for installation and connection to this Division all starters, controllers and disconnect switches which are furnished with their equipment but not integrally mounted.

D. This Division shall furnish, install, and connect all required starters and disconnect switches which are not provided with the served equipment. Where disconnect switches are not provided with served equipment and are required by the NEC or the local inspection department, then they shall be provided by the Electrical Contractor.

E. This Division shall furnish and install all interconnecting power wiring and make all connections ready for operation between motors, starters and control devices, as required by wiring diagrams (on approved Shop Drawings) provided by the Division furnishing the Equipment.

F. Unless otherwise indicated or specified, motors 1/2 hp and smaller shall be 120 or 240 volt, single phase, and shall be furnished with integral thermal overload protection. Provide manual disconnect switches as required. Where motors are not furnished with integral thermal overload protection, provide manual or magnetic starters as required.

G. Unless otherwise indicated or specified, motors 3/4 hp size and larger shall be 3-phase.

H. Motors 3/4 hp through 50 hp shall be furnished with "across-the-line", full-voltage nonreversing (FVNR) magnetic starters, unless otherwise indicated or specified.

I. Motors 60 hp and larger shall be furnished with reduced voltage nonreversing (RVNR) magnetic starters of the type indicated.

J. Where starters require disconnect switches in the immediate vicinity, combination motor starters shall be used. Where starters are mounted on equipment served, the switch shall not inhibit removal of any service panels or interfere with any required access areas.

3.2 CONTRACTOR AND OWNER-FURNISHED EQUIPMENT POWER CONNECTIONS:

A. All power connections to motors and equipment furnished by other Divisions or by Owner shall be made by this Division unless noted otherwise on the Drawings. This Division shall provide and install all power wiring and shall make all final connections.
B. Refer to the Drawings, approved Shop Drawings, other applicable Divisions and Owner-furnished equipment drawings for required power connections to equipment and motors.

C. All motorized or electrically operated equipment will be set in place by the furnishing Division with all integrally mounted starters, controls, and disconnect switches installed. The furnishing Division will furnish for installation and connection to this Division all starters, controllers, and disconnect switches which are furnished with their equipment but not integrally mounted.

D. This Division shall furnish, install, and connect all required starters and disconnect switches which are not provided with the served equipment. Where disconnect switches are not provided with served equipment and are required by the NEC or the local inspection department, then they shall be provided by the Electrical Contractor.

E. This Division shall furnish and install all interconnecting power wiring and make all connections ready for operation between equipment, starters and control devices, as required by wiring diagrams (on approved Shop Drawings) provided by the Division furnishing the Equipment.

F. All connections to Contractor and Owner-furnished equipment shall be made in a suitable manner.

G. Plug types on cord connected equipment shall be coordinated with the receptacle to provide compatibility. Where the installed plug and receptacle are not compatible, then this contractor shall be responsible for changing either the plug or receptacle as required for compatibility.

H. Where starters, disconnect switches, conduit boxes, or other items are mounted directly on the equipment served, the mounting location shall not inhibit removal of any required service panels or interfere with any required access areas.

I. All conduits shall terminate in conduit boxes on equipment where possible. A piece of flexible or liquidtight flexible conduit (Refer to Section 26 05 33, "Electrical Raceways") not less than 12" long nor more than 24" long, shall be connected between the conduit and the equipment. Where equipment is not provided with conduit boxes, terminate the conduit in a suitable manner at the equipment.

J. Outlets of various types have been shown at equipment locations, but no indications of exact locations or scope of work is intended on the accompanying Drawings. The Contractor shall determine the exact location of all items:
   1. From the applicable Drawings and Specifications and Shop Drawings of the Divisions furnishing the equipment.
   2. From the Contractors responsible for the equipment involved.
   3. By actual measurements at the site.
   4. By direction from the Owner.

K. Prior to installation, coordinate power, rough-in and control provisions shown on the drawings for radiology equipment with the provisions shown on approved Shop Drawings for the furnished radiology equipment. Where the power, rough-in and control requirements are less than or equal to those shown, then modifications to power, rough-in and control provisions shown shall be made at no cost as a matter of job coordination. Where power and control requirements are in excess of those shown, notify the Engineer in writing of the requirements.

L. Prior to installation, coordinate power and control provisions for Contractor and Owner-furnished equipment with approved equipment shop drawings. Where power and control provisions are significantly different than those shown, notify the Engineer in writing of the
requirements. Where minor modifications to provisions are required, they shall be made at no cost as a matter of job coordination.

3.3 INSTALLATION OF ELECTRICAL CONNECTIONS:

A. General: Install electrical connections as shown, in accordance with applicable portions of the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended functions.

B. Conductors: Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Wherever possible, match conductors of the electrical connection for proper interface between the electrical supply and the installed equipment.

C. Splice Insulation: Cover splices with electrical insulation equivalent to, or of a higher rating than, insulation on the conductors being spliced.

D. Appearance: Prepare cables and wires by properly cutting and stripping covering, jacket and insulation to ensure a uniform and neat appearance where cables and wires are terminated.

E. Routing: Trim cables and wires to be as short as practicable and arrange routing to facilitate inspection, testing, and maintenance.

F. Polyvinyl Chloride (PVC) Coated Conduit: Provide PVC-coated rigid steel conduit and fittings where required for highly-corrosive atmospheres.

G. Flexible Conduit: Provide flexible conduit, minimum 18" for connection of lighting fixtures and other electrical equipment connections, where subject to movement and vibration.

H. Liquidtight Conduit: Provide liquidtight flexible conduit, minimum 18" for connection of all motors and for other electrical equipment where subject to movement and vibration, and also where subjected to one or more of the following conditions:

1. Exterior location.
2. Moist or humid atmosphere where condensate can be expected to accumulate.
3. Corrosive atmosphere.
4. Subjected to water spray.
5. Subjected to dripping oil, grease, or water.
7. Lift Stations.

I. Conduit Location: All horizontal runs of conduit (not strapped to walls) shall be above 8' high, with a vertical drop to equipment. Conduit blocking walk and service space will not be acceptable and will require relocation. Conduit on and adjacent to equipment shall be located to allow free access to all removable panels for equipment service.

J. Motor Connections: Where possible, terminate conduit in conduit boxes at motors. Where motors are not provided with conduit boxes, terminate the conduit in a suitable condulet, and make motor connections. All conduit passing through the housing on connected equipment shall pass through a cleanly cut hole protected with an approved grommet.

K. Coordination: Coordinate installation of electrical connections for equipment with equipment installation work.

L. Identification: Refer to Section 260553, "Identification for Electrical Systems", for identification of electrical power supply conductor terminations with markers approved as to type, color, letter, and marker size by the Architect. Affix markers at each point of termination, as close as possible to each point of connection.
PART 1 - GENERAL

1.1 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions and Supplementary General Conditions, Division 1 General Requirements, and 2600 01 Electrical General Provisions, apply to this section.

1.2 DESCRIPTION OF WORK:
A. Work Included: Provide wiring device work as shown, scheduled, indicated, and as specified.
B. Types: The types of wiring devices required for the project include, but are not limited to, the following:
   1. Receptacles.
   2. Switches.
   3. Wallbox dimmers.
   4. Pushbuttons.
   5. Wall plates.

1.3 STANDARDS:
A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:
   1. NEMA WE 1  General-purpose wiring devices.
   2. NEMA WD 5  Specific-purpose wiring devices.

1.4 QUALITY ASSURANCE:
A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
   1. Bryant.
   2. Harvey Hubbell, Inc.
   3. Intermatic.
   4. Leviton.
   5. Lightolier, Inc.
   6. Lutron, Inc.
   7. Pass and Seymour, Inc.
   8. Prescolite.
   9. Raco.
   10. Taymac Corporation.
B. UL Label: All wiring devices shall be UL-labeled.

1.5 SUBMITTALS:
A. Shop Drawings submittals shall include, but not be limited to, the following:
1. Cut sheets of the receptacles, switches, wall box dimmers, and pushbuttons.
2. Cut sheets of the wall plates.
3. Additional information as required in Section 260001, “Electrical General Provisions”.

1.6 DELIVERY, STORAGE AND HANDLING:
A. Deliver wiring devices individually wrapped in factory-fabricated containers.
B. Handle wiring devices carefully to avoid damage, breaking, and scoring.
C. Store in a clean dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 WIRING DEVICES:
A. General: Provide factory-fabricated wiring devices in the type, color, and electrical rating for the service indicated. Where type and grade are not indicated, provide proper selection to correspond with branch circuit wiring and overcurrent protection. Attachment of wires to devices shall be by screw pressure under the head of binding screws. Arrangements depending on spring pressure or tension are not acceptable. All binding screws shall be brass or bronze.

B. Receptacles: Comply with NEMA Standard WD1 and as follows:

1. General Duty Decorator: Provide simplex or duplex commercial specification grade decorator type receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke, with metal mounting straps, back and side wired with screw type terminals, molded high impact thermoplastic compound, NEMA configuration as indicated.

   a. 20 amp, 125 volt grounded simplex NEMA #5-20R  
       Pass & Seymour #26361-*.  
       Leviton #16351-*.

   b. 15 amp, 125 volt grounded duplex NEMA #5-15R  
       Pass & Seymour #26252-*.  
       Leviton #16252-*.

   c. 20 amp, 125 volt grounded duplex NEMA #5-20R  
       Pass & Seymour #26352-*.  
       Leviton #16352-*.

   d. 20 amp, 125 volt, Class A, GFCI duplex receptacle with integral ground fault current interrupter, back and side wired with indicator light.

   e. 20 amp, 125 volt, Class A, GFCI duplex receptacle with integral ground current interrupter, back and side wired with indicator light hospital grade.

   f. 20 amp, 125 volt, Class A, GFCI duplex weather resistant receptacle with integral ground fault interrupter.

   * Color designation, refer to Paragraph 2.3.

2. General Duty Standard: Provide simplex or duplex commercial specification grade standard type receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke, with metal mounting straps, back and side wired with screw type terminals, molded high impact thermoplastic compound, NEMA configuration as indicated.

   a. 20 amp, 125 volt, Class A, GFCI duplex receptacle with integral ground fault interrupter.

   b. 20 amp, 125 volt, Class A, GFCI duplex receptacle with integral ground fault interrupter, back and side wired with indicator light hospital grade.

   c. 20 amp, 125 volt, Class A, GFCI duplex weather resistant receptacle with integral ground fault interrupter.

   * Color designation, refer to Paragraph 2.3.
WIRING DEVICES

3. **Heavy-duty Simplex:** Provide single heavy-duty type receptacles, with green hexagonal equipment ground screw, with metal mounting straps, back wiring, black molded phenolic compound, NEMA configuration as indicated.
   
a. 30 amp, 125 volt grounded single receptacle NEMA #5-30R
   Hubbell #HBL9308 with #S703 stainless steel wall plate.

b. 30 amp, 250 volt, grounded, 3-wire, 2-pole NEMA #6-30R
   Hubbell #HBL9330 with #S703 stainless steel wall plate.

c. 20 amp, 125/250 volt, grounded, 4-wire, 3-pole NEMA #14-20R
   Hubbell #HBL9430A with #S701 stainless steel wall plate.

d. 30 amp, 125/250 volt, grounded, 4-wire, 3-pole NEMA #14-30R
   Hubbell #HBL2710 with #7420 cast locking, 4 wire, 3-pole NEMA #L14-30R aluminum weatherproof wall plate.

3. **Data Receptacles Decorator:** Provide simplex or duplex commercial specification grade decorator type receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke, with metal mounting straps, back and side wired with screw type terminals, molded high impact thermoplastic compound, NEMA configuration as indicated.

   a. 15 amp, 125 volt, grounded duplex receptacle NEMA #5-15R
      Pass & Seymour #26252-*.
      Leviton #16252-*.

   b. 20 amp, 125 volt, grounded duplex receptacle NEMA #5-20R
      Pass & Seymour #26352-*.
      Leviton #16352-*.

   c. 15 amp, 125 volt, isolated grounded duplex receptacle NEMA #5-15R
      Pass & Seymour #IG 26262-*.
      Leviton #16262-IG*.

   d. 20 amp, 125 volt, isolated grounded duplex receptacle NEMA #5-20R
      Pass & Seymour #IG 26362-*.
      Leviton #16362-IG*.

   e. 20 amp, 125 volt, grounded twist lock, simplex receptacle NEMA #L5-20R
      Pass & Seymour #L520R.
      Leviton #2310

   f. 30 amp, 125 volt, grounded twist lock, simplex receptacle NEMA #L5-30R
      Pass & Seymour #L530R.
      Leviton #2610.

   g. 15 amp, 250 volt, grounded twist lock, simplex receptacle NEMA #L6-15R
      Pass & Seymour #4560.
      Leviton #4560-FR.

* Color designation, refer to Paragraph 2.3.
5. Data Receptacles Standard: Provide simplex or duplex commercial specification grade standard type receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke, with metal mounting straps, back and side wired with screw type terminals, molded high impact thermoplastic compound, NEMA configuration as indicated.

   a. 15 amp, 125 volt, grounded duplex receptacle NEMA #5-15R
       Pass & Seymour #5252-*.
       Leviton #BR15-*.

   b. 20 amp, 125 volt, grounded duplex receptacle NEMA #5-20R
       Pass & Seymour #5352-*.
       Leviton #BR20-*.

   * Color designation, refer to Paragraph 2.3.

6. Housekeeping Receptacles: Provide simplex specification grade twist-lock receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, NEMA configuration as indicated.

   a. 20 amp, 125 volt grounded simplex
       NEMA #L5-20R
       Pass & Seymour #2310*.

   * Color designation, refer to Paragraph 2.3.

7. Transient Voltage Surge Suppression Receptacles: Provide duplex commercial specification grade decorator type receptacles, 2-pole, 3-wire, grounding, with integral surge suppression, green hexagonal equipment ground screw, back and side wired with screw type terminals, NEMA configuration as indicated. Surge suppressor shall provide an equal surge protection of not less than 80 joules in all three modes (hot to neutral, hot to ground, and neutral to ground), minimum 7:1 RFI and EMI noise suppression and a front face LED indicator for positive indication of surge protection. Surge suppression receptacles shall comply with LIL 1449 (Category A&B) and ANSI/IEEE 62.41-1991.

   a. 15 amp, 125 volt, surge suppression
duplex NEMA #5-15R
   Pass & Seymour #6262-*-SP.
   Leviton #8280-*-SP.

   b. 20 amp, 125 volt, surge suppression
duplex NEMA #5-20R
   Pass & Seymour #6362-*-SP.
   Leviton #8380-*-SP.

   c. 15 amp, 125 volt, isolated ground surge
duplex NEMA #5-15R
   Pass & Seymour #IG 6261-*-SP.
   Leviton #8280-IG*.

   d. 20 amp, 125 volt, isolated ground surge
duplex NEMA #5-20R
   Pass & Seymour #IG 6362-*-SP.
   Leviton #8380-IG*.

   * Color designation, refer to Paragraph 2.3.

8. General Duty Clock Simplex: Provide single commercial specification grade type receptacles, 2-pole, 3-wire grounding, recessed to contain male plug and permit clock to cover outlet, with metal hook for supporting clock, ivory molded phenolic compound, side wired with screw type terminals, NEMA configuration as indicated.

   a. 15 amp, 125 volt, grounded single
      NEMA #5-15R
      Pass & Seymour #S3713-I.
      Leviton #688-I
9. Specific-use receptacles shall have volts, amps, poles, and NEMA configuration as noted on Drawings.

C. Switches: Comply with NEMA Standard WD1 and as follows:

1. Rocker: Provide commercial specification grade flush rocker switches, with mounting yoke insulated from mechanism, equipped with plaster ears, white switch rocker and side-wired screw terminals.
   a. Single pole, 120/277 volt, 20 amp switch Pass & Seymour #2621*.
      Leviton #5621-2*.
   b. Three-way, 120/277 volt, 20 amp switch Pass & Seymour #2623*.
      Leviton #5623-2*.
   c. Four-way, 120/277 volt, 20 amp switch Pass & Seymour #2624*.
      Leviton #5624-2*.
   d. Single Pole, 120/277 volt, 20 amp, switch illuminated when on Pass & Seymour #2629*.
      Leviton #5628-2*.
   e. Single pole, double throw, momentary, contact center off, 120/277 volt, 15 amp switch Leviton #5657-2*.

   * Color designation, refer to Paragraph 2.3.

2. Toggle: Provide commercial specification grade flush toggle switches, with mounting yoke insulated from mechanism, equipped with plaster ears, white switch handle, side-wired terminals, horsepower rated.
   a. Single pole, 120/277 volt, 20 amp, switch key operated Pass & Seymour #PS20AC1-KL.
      Leviton #1221-2K*L.
   b. Single pole, 120/277 volt, 20 amp switch Pass & Seymour #20AC1-*.
      Leviton #CSB1-20*.
   c. Three-way, 120/277 volt, 20 amp switch Pass & Seymour #20AC3-*.
      Leviton #CSB3-20*.
   d. Single pole, 120/277 volt, 20 amp switch, red pilot light Pass & Seymour #20AC1-RPL.
      Leviton #1221-PLR.
   e. Single pole, double throw, momentary, contact center off, 120/277 volt, 20 amp switch Pass & Seymour #1091-*.
      Leviton #1285-*.

   * Color designation, refer to Paragraph 2.3.

D. Decorator Wall Box Dimmers: Provide commercial specification grade linear slide dimmers with separate positive on/off button and LED indicator, voltage compensation circuitry for constant light output and toroidal filters for suppression of RFI and lamp sing. Dimmers shall be "decorator face" size and shall gang with standard decorator rocker switches. Wall box dimmers shall be as follows:

1. Single pole, 120 volt, 600 watt dimmer Lightolier #ZP600-*.
2. Single pole, 120 volt, 1,000 watt dimmer Lightolier #ZP1000-*.
3. Single pole, 120 volt, 600 watt inductive load dimmer Lightolier #ZP600VA-*.
4. Single pole, 120 volt, 1,000 watt inductive load dimmer Lightolier #ZP1000VA-*.
5. Single pole, 120 volt, 260 watt electronic transformer low voltage dimmer Lightolier #ZP260QE-*.
6. Single pole, 120 volt, 425 watt electronic transformer low voltage dimmer Lightolier #ZP425QE-*.
7. Multiple location remote on-off switch Lightolier #ZPR-3-*.
E. Custom Wall Box Dimmers: Provide commercial specification grade linear slide dimmers with separate positive on-off switch with LED indicator, voltage compensation circuitry for constant light output and toroidal filters for suppression of RF and lamp sing. Matching switches shall be available for ganging with dimmers. Ganged dimmers and/or switches shall be provided with a single coverplate to match the installed configuration. Wall box dimmers shall be as follows:

1. Single pole, 120 volt, 600 watt dimmer Lightolier #MP600-*.
2. Single pole, 120 volt, 1000 watt dimmer Lightolier #MP1000-*.
3. Single pole, 120 volt, 1500 watt dimmer Lightolier #MP1500-*.
4. Single pole, 120 volt, 2000 watt dimmer Lightolier #MP2000-*.
5. Single pole, 120 volt, 600 watt inductive load dimmer Lightolier #MP600VA-*.
6. Single pole, 120 volt, 1000 watt inductive load dimmer Lightolier #MP1000VA-*.
7. Single pole, 120 volt, 1500 watt inductive load dimmer Lightolier #MP1500VA-*.
8. Single pole, 120 volt, 2000 watt inductive load dimmer Lightolier #MP2000VA-*.
9. Single pole, 120 volt, 525 watt electronic transformer low voltage dimmer Lightolier #MP525QE-*.
10. Single pole, 120 volt, 625 watt electronic transformer low voltage dimmer Lightolier #MP625QE-*.
11. Multiple location remote on-off remote Lightolier MRP-3-*.
12. Matching single pole switch Lightolier MP-1P-*.
13. Matching 3-way switch Lightolier MP-3P-*.
14. Matching 4-way switch Lightolier MP-4P-*.
15. Dimmer ganging faceplates Lightolier FB/NFB/Custom as required-*.

* Color designation, refer to Paragraph 2.3.


2.2 WIRING DEVICE ACCESSORIES:

A. Wall Plates: Provide switch, duplex outlet and telephone [screwless] wall plates, with single or multigang cutouts as indicated, [complete with metal screws for securing plates to devices.] Screw heads shall be colored to match finish of plate. Wall plates shall possess the following additional construction features:

1. Material and Finish:
   a. Specification grade, smooth, high impact thermoplastic and Lexan for general duty receptacles, data receptacles, and switches. Pass & Seymour #RP series or approved equal. Jumbo plates are not acceptable.
   b. Specification grade, Type 302, satin-finished stainless steel, 0.1” thick for heavy duty receptacles and kitchen receptacles.
   c. Specification grade, weatherproof, coverplate, gasketed UV stabilized polycarbonate with hinged gasketed device cover, for exterior and wet area receptacles. Coverplates shall be NEMA 3R rated and shall be watertight.
when in use. Coverplates shall be as manufactured by Taymac Corporation, RACO, Intermatic or an approved equal.

d. Specification grade, Type 316 satin-finished stainless steel, 0.030” thick for general duty receptacles and switches for elevator lobbies, entrance lobbies, restrooms, and public areas.

2.3 WIRING DEVICE/COVERPLATE COLORS:

A. **General**: Provide general duty wiring devices and coverplates in colors as follows:

1. **Painted Drywall**: Provide white general use receptacles and switches and gray data receptacles with matching white thermoplastic coverplates in occupied areas and white Lexan coverplates in mechanical/electrical and maintenance areas.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Installer must examine the areas and conditions under which wiring devices and floor boxes are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Inspect devices for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF WIRING DEVICES:

A. **General**:

1. Install wiring devices where shown, in accordance with manufacturer’s written instructions, applicable requirements of NEC and in accordance with recognized industry practices to ensure that products serve intended function. Delay installation of devices until wall construction and wiring is completed.

2. Special purpose switches and/or outlets not covered by the specifications, but noted on the Drawings shall be of the amperage, voltage rating, and NEMA configuration indicated. The switches and/or outlets shall be specification grade of the same quality as those specified.

3. When "EQUIPMENT ONLY" or "JUNCTION BOX ONLY" is indicated for equipment, it shall be the responsibility of the Electrical Subcontractor to obtain from the supplier, the complete data as related to the electrical portion of the equipment, including rough-ins, mounting height, type of outlet, items furnished by the supplier, etc. The Electrical Subcontractor shall be responsible for furnishing and installing all materials which are usually the Electrical Subcontractor's responsibility with the installation of the equipment.

4. The approximate location of switches, power outlets, floor boxes, etc., is indicated on the Drawings. These Drawings, however, may not give complete and accurate information in regard to locations of such items. Determine exact locations by reference to the general building Drawings and by actual measurements during construction of the building before rough-in, subject to the approval of the Construction Inspector.

B. **Box Condition**: Install receptacles and switches only in electrical boxes which are clean, free from excess building materials, debris, and similar matter.

C. **Alignment**: Install all wiring devices plumb and aligned in the plane of the wall, floor, or ceiling in which they are installed.
D. **Switches and Dimmers**: Install switches and wall box dimmers at a height as specified in Section 260501, "Electrical Basic Materials and Methods", to switch center line, unless otherwise noted on Drawings, on the strike side of doors as hung and in a uniform position so that the same direction will open and close the circuit throughout the project. Where shown near doors, install switches and dimmers not less than 2" and not more than 12" from door trim. Where more than one switch is in the same location, install switches in a multi-gang box with a single coverplate. Use toggle switches for motor disconnect switches only when installed in a ceiling plenum or in a mechanical, electrical, or telephone room.

E. **Receptacles**: Install receptacles vertically at a height as specified in Section 260501, "Electrical Basic Materials and Methods", to receptacle center line above finished floor and horizontally at a height as specified in Section 260501, "Electrical Basic Materials and Methods", to receptacle center line above counter tops unless shown or specified otherwise. Where splash backs occur above counters, mount devices horizontally at a height as specified in Section 260501, "Electrical Basic Materials and Methods", to receptacle center line above splash backs. **Receptacles shall be installed with ground pin receiver down**. All devices shall be installed complete with coverplates. Use 20 ampere receptacle when only one receptacle is installed on a branch circuit. Coverplates:

1. Install stainless steel coverplates on all heavy-duty receptacles and wiring devices located in kitchen areas. Coffee bars shall not be considered kitchen areas. Install weatherproof coverplates on all exterior and wet area receptacles. Refer to Paragraph 2.03 for additional requirements.
2. Multi-gang wall plates shall be used for each group of ganged devices. Mounting screws shall be installed for each device covered by the wall plate.
3. Wall plates for concealed work shall be flush against the finished wall, and shall completely cover the wall opening. Wall plates shall not be installed until all painting has been completed. Devices shall be protected by masking tape or other coverage until painting is complete. Any device with paint on it shall be replaced at no expense to the Owner. Jumbo plates are not acceptable.
4. Engrave and black paint fill text descriptions and branch circuit numbers on switch and receptacle coverplates where shown on the Drawings or specified herein.

F. **Mounting Heights**: Refer to Section 260501, "Electrical Basic Materials and Methods", for wiring device mounting heights.

G. **Power Poles**: Power poles shall be roughed-in with the project construction, however the actual installation and connection of poles shall be delayed until final furniture locations are determined by the user of the space.

H. **Cord Reels**: Install cord reels above ceiling with roller outlet protruding through ceiling. Provide miscellaneous metal support above ceiling to support reel and trim plate at ceiling cutout.

3.3 **PROTECTION OF WALL PLATES AND RECEPTACLES**:

A. General: Upon installation of wall plates and receptacles, advise Contractor regarding proper and cautious use of convenience outlets. At time of Substantial Completion, replace those items which have been damaged, including those burned and scored by faulty plugs.

3.4 **IDENTIFICATION**:

A. Refer to Section 260553, “Identification for Electrical Systems”, for wiring device identification requirements.

3.5 **TESTING**:
A. **General:** Prior to energization, check for continuity of circuits, for short circuits and check grounding connections. After energization, check wiring devices to demonstrate proper operation and receptacle polarization.

END OF SECTION 262726
SECTION 262817

ENCLOSED CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions and Supplementary General Conditions, Division 1 General Requirements, and 26 00 01 Electrical General Provisions, apply to this section.

1.2 DESCRIPTION OF WORK:
A. Work Included: Provide enclosed circuit breaker work as shown, scheduled, indicated, and as specified.

1.3 STANDARDS:
A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:
   1. Federal Spec. W-S-865 Switch, Box (Enclosed), Surface-Mounted.
   2. NEMA KS 1 Enclosed Switches.

1.4 QUALITY ASSURANCE:
A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
   1. Eaton.
   2. General Electric Company.
   3. Siemens.
   4. Square D Company.

B. UL-Label: Enclosed circuit breakers shall have Underwriters' Laboratories, Inc., approval and bear the UL label.

C. Interrupting Ratings: Short circuit analysis and coordination study specified in Section 260573 “Short Circuit Analysis/Coordination Study” shall be completed and submitted with switchboard submittal to confirm interrupting rating of submitted equipment is adequate for the point of application in the electrical distribution.

1.5 SUBMITTALS:
A. Shop drawing submittals shall include, but not be limited to, the following:
   1. Cut sheets of the enclosed circuit breakers with ratings, voltage, poles, capacity, horsepower, short circuit rating, and all associated accessories clearly indicated.
   2. Include dimensioned drawings of enclosed circuit breakers which have a rating of 225 amperes or larger, showing the accurately scaled enclosures and their layout, and relation to associated equipment.
   3. The Short Circuit Analysis, Protective Device Coordination Study and Arc Flash and Electrical Hazard Studies specified in Section 260573, “Short Circuit
Analysis/Coordination Study” shall be completed and submitted prior to submitting submittals for this section.

4. Additional information as required in Section 26 00 01.

1.6 DELIVERY, STORAGE AND HANDLING:

A. Deliver circuit breakers individually wrapped in factory-fabricated water-resistant type containers.

B. Handle circuit breakers carefully to avoid damage to material components, enclosure and finish. Damaged switches shall not be installed on project.

C. Store circuit breakers in a clean and dry space and protect from weather.

PART 2 - PRODUCTS

2.1 MOLDED CASE CIRCUIT BREAKERS:

A. General: Provide enclosed, molded-case circuit breaker conforming to NEMA AB 1, suitable for use as service entrance equipment where so applied.

B. Solid-State Circuit Breakers: Enclosed circuit breakers 400 ampere frame and above shall be equipped with solid-state programmable trip complete with built-in current transformers, solid-state trip unit and flux transfer shunt trip. The solid-state electronic programmable trip device shall have the following features and tripping functions.

1. Adjustable current setting.
2. Adjustable long-time delay.
3. Adjustable instantaneous pick-up.
4. Adjustable short time delay.
5. Adjustable short time pick-up.
6. [Adjustable ground fault delay]
7. [Adjustable ground fault pick-up]

C. Interrupting Capacity: Provide distribution panel circuit breakers with conventional interrupting capacity unless scheduled shown or noted otherwise, but in no case less than the following symmetrical amperes RMS:

<table>
<thead>
<tr>
<th>Frame Size/Voltage (volts)</th>
<th>Interrupting Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>100AF to 225AF/240V</td>
<td>10,000 AIC</td>
</tr>
<tr>
<td>400AF to 1000AF/240V</td>
<td>42,000 AIC</td>
</tr>
<tr>
<td>1200AF/240V</td>
<td>100,000 AIC</td>
</tr>
<tr>
<td>100AF/480V</td>
<td>18,000 AIC</td>
</tr>
<tr>
<td>225AF/480V</td>
<td>25,000 AIC</td>
</tr>
<tr>
<td>400AF to 1000AF/480V</td>
<td>30,000 AIC</td>
</tr>
<tr>
<td>1200AF/480V</td>
<td>50,000 AIC</td>
</tr>
</tbody>
</table>

D. Accessories: As scheduled on drawings. Conform to NEMA AB 1.

1. Shunt Trip Device: 120 volts, AC, where specified or noted.
2. Undervoltage Trip Device: 120 volts, AC, where specified or noted.
3. Auxiliary Switch: 120 volts, AC, where specified or noted.
4. Alarm Switch: 120 volts, AC, where specified or noted.
5. Electrical Operator: 120 volts, AC, where specified or noted.
7. Insulated Grounding Lug: In each enclosure.

E. Enclosures: NEMA AB 1, as required to meet conditions. Fabricate enclosure from steel finished with manufacturer’s standard gray enamel aluminum.

1. Interior Dry Locations: NEMA Type 1
2. Exterior Locations: NEMA Type 3R.
3. Industrial Locations: NEMA Type 4X

F. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Provide solid neutral assembly and equipment ground bar.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Installer shall examine the areas and conditions under which safety and disconnect switches are to be installed and notify the Engineer in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF ENCLOSED CIRCUIT BREAKERS:

A. General: Install enclosed circuit breakers where shown, in accordance with the manufacturer's written instructions, the applicable requirements of the NEC, the NECA’s "Standard of Installation", and recognized industry practices to ensure that products serve the intended function.

B. Location: Provide enclosed circuit breakers where shown and at each motor which is out-of-sight-of or greater than 50' from the switch or panel from which the motor circuit is fed, unless another NEC complying disconnecting method is utilized.

C. Supports: Provide all enclosed circuit breakers with galvanized angle or other suitable supports where mounting on wall or other rigid surface is impractical. Switches shall not be supported by conduit alone. Where safety and disconnect switches are mounted on equipment served, the switch shall not inhibit removal of any service panels or interfere with any required access areas. Install enclosed circuit breakers plumb. Provide supports.

D. Height: 5 feet to operating handle.

3.3 ADJUSTING:

A. Adjust trip settings so that circuit breakers coordinate with other overcurrent protective devices in circuit.

B. Adjust trip settings to provide adequate protection from overcurrent and fault currents.

3.4 TESTING:

A. General: Prior to energization, check for continuity of circuits and for short circuits.

3.5 IDENTIFICATION:

A. Refer to Section 260553, "Identification for Electrical Systems", for applicable painting, nameplates, and labeling requirements.

END OF SECTION 262817
SECTION 262818
ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions and Supplementary General Conditions, Division 1 General Requirements, and 26 00 01 Electrical General Provisions, apply to this section.

1.2 DESCRIPTION OF WORK:
A. Work Included: Provide safety and disconnect switch work as shown, scheduled, indicated, and as specified.
B. Types: The types of safety and disconnect switches required for the project include, but are not limited to, equipment disconnects and motor-circuit disconnects.

1.3 STANDARDS:
A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:
   1. Federal Spec. W-S-865 Switch, Box (Enclosed), Surface-Mounted.
   2. NEMA KS 1 Enclosed Switches.

1.4 QUALITY ASSURANCE:
A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
   2. Eaton.
   4. Siemens.
   5. Square D Company.
B. UL-Label: Safety and disconnect switches must have Underwriters’ Laboratories, Inc., approval and bear the UL label.

1.5 SUBMITTALS:
A. Shop drawing submittals shall include, but not be limited to, the following:
   1. Cut sheets of the safety and disconnect switches with ratings, voltage, poles, capacity, horsepower, short circuit rating, and all associated accessories clearly indicated.
   2. Include dimensioned drawings of electrical safety and disconnect switches which have a rating of 100 amperes or larger, showing the accurately scaled switches, their layout, and relation to associated equipment.
   3. Additional information as required in Section 26 00 01, “Electrical General Provisions”.
1.6 DELIVERY, STORAGE AND HANDLING:
   A. Deliver switches individually wrapped in factory-fabricated water-resistant type containers.
   B. Handle switches carefully to avoid damage to material components, enclosure and finish. Damaged switches shall not be installed on project.
   C. Store switches in a clean and dry space and protect from weather.

PART 2 - PRODUCTS

2.1 MATERIAL:
   A. General: Provide heavy-duty type, dead front, sheet steel-enclosed, surface-mounted safety switches of the type and size indicated. Safety switches shall be rated for the voltage of the circuit in which they are installed. Safety switches used as motor disconnects shall be horsepower rated for the motor served.
   B. Switch Mechanism:
      1. Safety switches shall be quick-make quick-break type with permanently attached arc suppressors and constructed such that switch blades are visible in the "OFF" position with the door open. The operating handle shall be an integral part of the box, not of the cover. Switch shall have provision to padlock in the "OFF" position. Safety switches shall have a cover interlock to prevent unauthorized opening of the switch door when the switch mechanism is in the "ON" position or closing of the switch mechanism when the switch door is open.
      2. Cover interlock shall have an override mechanism to permit switch inspection by authorized personnel. **All current-carrying parts shall be constructed of high conductivity copper with silver-plated switch contacts.** Lugs shall be copper-plated or aluminum, suitable for copper or aluminum cable and front removable. **Switch blades shall be copper.**
   C. Fusing: Provide fusible safety switches where indicated. Fuse clips shall be positive pressure rejection type fuse clips suitable for use with UL Class R fuses.
   D. Neutral: Provide safety switches with number of switched poles as indicated. Where a neutral is present in the circuit, provide a solid neutral with the safety switch.
   E. Enclosures:
      1. All safety switches installed in indoor locations shall be NEMA 1 general purpose enclosures unless otherwise shown.
      2. Safety switches installed in exterior locations or where exposed to outdoor conditions shall be NEMA 3R (water resistant) unless otherwise shown or specified.
      3. Safety switches installed in wet areas shall be NEMA 4 (stainless steel), unless otherwise shown.

PART 3 - EXECUTION

3.1 INSPECTION:
   A. Installer shall examine the areas and conditions under which safety and disconnect switches are to be installed and notify the Engineer in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
3.2 INSTALLATION OF SAFETY AND DISCONNECT SWITCHES:
   A. General: Install safety and disconnect switches where shown, in accordance with the manufacturer's written instructions, the applicable requirements of the NEC, the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended function.
   B. Location: Provide safety switches where shown and at each motor which is out-of-sight-of or greater than 50' from the switch or panel from which the motor circuit is fed, unless another NEC complying disconnecting method is utilized.
   C. Supports: Provide all safety and disconnect switches with galvanized angle or other suitable supports where mounting on wall or other rigid surface is impractical. Switches shall not be supported by conduit alone. Where safety and disconnect switches are mounted on equipment served, the switch shall not inhibit removal of any service panels or interfere with any required access areas.
   D. Disconnect Switches: Install disconnect switches used with motor-driven appliances, motors, and controllers within sight of the controller position unless otherwise indicated.
   E. Coordination: Coordinate safety and disconnect switch installation work with electrical raceway and cable work as necessary for proper interface.

3.3 TESTING:
   A. General: Prior to energization, check for continuity of circuits and for short circuits.

3.4 IDENTIFICATION:
   A. Refer to Section 26 05 53, "Identification for Electrical Systems", for applicable painting, nameplates, and labeling requirements.

END OF SECTION 26 28 18
SECTION 264313
SURGE PROTECTIVE DEVICES (SPDs)

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions and Supplementary General Conditions, Division 1 General Requirements, and 26 00 01 Electrical General Provisions, apply to this section.

1.2 SCOPE

A. This section includes Surge Protective Devices (SPDs) for low-voltage power equipment (1000Vac and less).

B. Work under this section consists of furnishing all materials necessary for the execution and complete installation of Surge Protective Devices (SPDs).

C. Refer to sheet E-501 detail 3 for lift station surge protection device model.

1.3 RELATED WORK/SECTIONS

A. In addition to this section, the Contractor shall refer to other specification sections and drawings to ascertain the extent of work included.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others except when permitted and then only after arranging to provide temporary utility services according to requirements indicated. Notify and coordinate with the engineer when an interrupt is required and prior to interrupting.

1.4 QUALITY ASSURANCE/REFERENCE STANDARDS

The SPD surge protection system shall be designed and manufactured, and where appropriate, listed to the following standards:

A. Underwriters Laboratory (UL)

1. UL1449 3rd Edition: Surge Protective Devices (SPD)

2. UL1283 5th Edition: Electromagnetic Interference Filters

3. cUL – UL: Evaluation to Canadian Safety Requirements (UL 1449, 1283)

B. Institute of Electrical & Electronic Engineers (IEEE)


C. National Electrical Manufacturers Association (NEMA)


F. MIL-STD 220A

1.5 PROJECT CONDITIONS

A. Service Conditions: The Surge Protective Device (SPD) shall be rated for continuous operation under the following conditions:

1. Maximum Continuous Operating Voltage (MCOV): 115% to 125% of the nominal operating voltage

2. Operating Temperature: -40°C to 60°C

3. Relative Humidity: 0% to 95%, non-condensing

4. Operating Altitude: 0 feet to 12,000 feet

1.6 SUBMITTALS

A. Alternate manufacturers shall submit specification compliance report and drawings ten (10) days prior to bid for consideration.

B. The specific item proposed and its area of application shall be indicated on the product specification sheet.

C. Submit certified test results for all models as follows:

UL listing verification:

1. Submit UL1449 3rd Edition Voltage Protection Ratings “VPR”.

2. Submit proof that products are UL listed and labeled by Underwriters Laboratories to UL 1449 3rd Edition.

D. Provide warranty statement.

1.7 LOCATIONS
A. See the electrical power riser diagram for Surge Protective Device (SPD) unit locations.

PART 2 - PRODUCTS

2.1 GENERAL

A. The following are the general requirements of the SPD products:

1. Nomenclatures used herein are intended to indicate product type and configuration of equipment required.

2. UL 1449 3rd Edition Listed, bearing the official UL 3rd Edition gold hologram label.


4. The Surge Protective Device (SPD) shall be a stand alone configuration. Systems that must be integral to the switchgear will not be considered.

5. All SPD systems shall be permanently connected, parallel designs. Series suppression elements shall not be acceptable.

6. The SPD shall be marked with a Short Circuit Current Rating (SCCR) and shall not be installed at a point on the system where the available fault current is in excess of that rating per the National Electric Code, Article 285, Section 6.

7. All SPD units shall be from the same manufacturer.

8. SPD designs using a single fuse to protect two (2) or more surge paths shall not be acceptable.

9. SPD designs that limit the 100% rated surge protection shall not be acceptable.

10. Fuse links or printed circuit board trace fusing shall not be acceptable.

11. Hybrid design utilizing:

(a) Thermally Protected Metal Oxide Varistors
(b) Filter capacitors to suppress EMI/RFI electrical noise.

2.2 MODULAR SURGE PROTECTION

A. Configured as shown on the riser diagram and/or panel schedules.
B. The SPD surge current ratings shall be based on the electrical system ampacity listed in the table below.

<table>
<thead>
<tr>
<th>Electrical System Ampacity @ SPD Install Point</th>
<th>Surge Protection (kA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per Mode</td>
</tr>
<tr>
<td>2500 – 6000A</td>
<td>300</td>
</tr>
<tr>
<td>1200 – 2000A</td>
<td>250</td>
</tr>
<tr>
<td>600 – 1000A</td>
<td>200</td>
</tr>
<tr>
<td>225 – 400A</td>
<td>150</td>
</tr>
<tr>
<td>125 – 225A</td>
<td>100</td>
</tr>
</tbody>
</table>

C. The SPD shall be rated for 240/120Vac 1 Phase, 3 Wire + Ground.

D. Modes of Protection: The SPD system shall provide surge protection in all possible modes (L-N, L-G, L-L, and N-G). Each replaceable module shall provide the uncompromising ability to deliver full surge current rating per mode.

E. SPD modules shall be configured to isolate individual suppression component failures without causing total loss of surge protection in that mode.

F. Opening of supplementary protective devices, internal or external, shall not be permissible during UL 1449 3rd Edition Nominal Discharge testing.

G. Optional Connection Methods: Fused Disconnect, 60A, #6AWG.

H. Each individual module shall feature a green LED indicating the individual module has all surge protection devices active. If any module is taken off-line, the green LED will turn off and a red LED will illuminate, providing individual module as well as total system status indication.


J. The modular SPD shall be provided in a NEMA 12 or 4X enclosure.

K. The SPD shall provide EMI/RFI electrical noise attenuation of 36 to 44dB in the range of 50kHz to 100MHz as defined by MIL-STD-220A test procedures.

L. Voltage Protection Ratings: The UL 1449 3rd Edition Voltage Protection Ratings “VPR” (6kV, 3000 Amps, 8/20µs waveform) shall not exceed the UL assigned values listed below.

<table>
<thead>
<tr>
<th>Voltage Protection Ratings (VPR)</th>
<th>Voltage Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>6kV, 3000A, 8/20µs Waveform</td>
<td>208/120V, 480/277V</td>
</tr>
<tr>
<td>Line to Neutral</td>
<td>900V, 1200V</td>
</tr>
<tr>
<td>Line to Ground</td>
<td>800V, 1200V</td>
</tr>
<tr>
<td>Neutral to Ground</td>
<td>700V, 1200V</td>
</tr>
<tr>
<td>Line to Line</td>
<td>1200V, 2000V</td>
</tr>
</tbody>
</table>
M. The SPD shall have a minimum UL 1449 3rd Edition Nominal Discharge Current Rating ($I_n$) of 10,000 Amps. When used in conjunction with a UL 96A certified Lightning Protection System the ($I_n$) rating shall be 20,000 Amps.

N. Approved Manufacturers: The following SPD manufacturers and respective models shall be deemed acceptable, subject to conformance with indicated requirements:

- THOR SYSTEMS TSr Product Series
- Current Technologies SL2 Product Series
- Liebert Intercepter II Series

PART 3 – EXECUTION

A. This section covers the execution and commissioning of the Surge Protective Device (SPD) required on this project.

B. Technical assistance shall be provided by the manufacturer through the efforts of a factory representative or a local distributor.

C. Verify absence of damage.

D. The unit shall be installed in accordance with the manufacturer’s printed instructions. All local and national codes shall be observed.

E. The unit shall be installed of the same voltage rating as the intended protected equipment.

F. The unit shall be installed on the load side of the service equipment overcurrent device.

G. The location of the field-mounted SPD shall allow adequate clearances for maintenance.

H. Lead Length: The mounting of the SPD shall ensure the connecting leads are as short (recommend one [1] meter or less) and straight (no sharp bends) as reasonably possible.

I. Before energizing the SPD, the unit shall be verified as to: correct as specified: manufacturer, product series, and model number.

J. All voltage modes including L-L (Line-to-Line), L-G (Line-to-Ground), L-N (Line-to-Neutral), and N-G (Neutral-to-Ground) shall be measured and verified against the unit voltage ratings.

K. Continuity measurements shall be made between the Neutral and Ground connections to verify the Neutral-to-Ground bond.

END OF SECTION 26 43 13
SECTION 265100

INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions and Supplementary General Conditions, Division 1 General Requirements, and 26 00 01 Electrical General Provisions, apply to this section.

1.2 DESCRIPTION OF WORK:
   A. Work Included: The extent of lighting fixture work is as shown and scheduled, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications. All materials, accessories, and any other equipment necessary for the complete and proper installation of all lighting fixtures included in this Contract shall be furnished by the Contractor.
   B. Types: The types of lighting fixtures required for the project may include, but are not limited to:
      1. Fluorescent fixtures.
      2. LED.
      3. Exit signs.
      4. Fluorescent emergency battery pack units.
   C. Applications: The applications of lighting fixtures required for the project include, but are not limited to:
      1. General lighting.
      2. Specialty lighting.
      3. Emergency, egress and exit lighting.
   D. Specifications and scale drawings are intended to convey the salient features, function and character of the fixtures only, and do not undertake to illustrate or set forth every item or detail necessary for the work.
   E. Minor details, not usually indicated on the drawings nor specified, but that are necessary for the proper execution and completion of the fixtures, shall be included, the same as if they were herein specified or indicated on the Drawings.
   F. The Owner shall not be held responsible for the omission or absence of any detail, construction feature, etc. which may be required in the production of the fixtures. The responsibility of accurately fabricating the fixtures to the fulfillment of this specification rests with the Contractor.
   G. All exterior lighting shall carry the dark sky label.

1.3 STANDARDS:
   A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:
      2. NEMA WD1 General-Purpose Wiring Devices.
      3. ANSI C82.1 Specification for Fluorescent Lamp Ballasts.
4. NEMA LE HID Lighting System Noise Criterion (LS-NC) Ratings.

1.4 QUALITY ASSURANCE:

A. Manufacturers: Provide products produced by manufacturers as shown or scheduled for each type of lighting fixture. Identification in the fixture schedule by means of manufacturers’ names and catalog numbers is to facilitate establishment of basic features, construction and performance standards. Any substitutions must, in the opinion of the Engineer, meet or exceed these standards. Provide products complying with these specifications and produced by one of the following for ballasts, lamps, and battery back-up units:

1. Ballast Manufacturers:
   a. Advance Transformer Company.
   b. Universal/Magnetek.
   c. Osram/Sylvania.
   d. Lutron.

2. Lamps:
   b. Osram Sylvania.

3. Emergency Battery Back-up Units:
   a. Bodine.
   b. Chloride.
   c. Lithonia.

B. CBM Label: Provide fluorescent ballasts which comply with Certified Ballast Manufacturers’ Association (CBM) standards and carry the CBM mark on the label.

C. Conformance: Fixtures shall be manufactured in strict accordance with the Drawings and Specifications.

D. Codes: Materials and installation shall be in accordance with the latest revision of the National Electrical Code and any applicable federal, state, and local codes and regulations.

E. UL-listing: All fixtures shall be manufactured in strict accordance with the appropriate and current requirements of the Underwriters’ Laboratories, Inc. "Standards for Safety," and others as they may be applicable. A UL-listing shall be provided for each fixture type, and the appropriate label or labels shall be affixed to each fixture in a position concealing it from normal view.

F. Warranty: All ballasts shall be provided with a two (2) year parts and labor warranty from the date of project acceptance.

1.5 SUBMITTALS:

A. Shop Drawings submittals shall include, but not be limited to, the following:

1. Submit manufacturer’s data on interior and exterior lighting fixtures in booklet form, with separate sheet for each fixture, assembled by fixture "type" in alphabetical order, with the proposed fixture and accessories clearly labeled. Ballast and lamp product data shall accompany fixture submittals. Submit
dimensioned drawings and performance data including coefficients of utilization, candel distribution, spacing to mounting height ratio, efficiency and visual comfort probability.

2. Submit details of fixture mounting including frames, trims, canopies, support requirements, and other data pertinent to fixture installation.

3. Submit complete photometric data for each fixture, including optical performance and efficiency rendered by independent testing laboratory developed according to methods of U.S.A. Illuminating Engineering Society as follows:
   a. For down and semi-down lights used for general illumination: (1) Coefficients of utilization; (2) Visual Comfort Probability data (fluorescent only) for 100 footcandles, in a 20' by 20' room with 10' ceiling and luminaires lengthwise with reflectances of 80% (ceiling), 50% (walls), and 20% (floor); (3) Candlepower data, presented graphically and numerically, in 5 degree increments (0 degrees, 5 degrees, 10 degrees, etc.). If light output is only bilaterally symmetric, data also developed for up and down quadrants normal, parallel, and at 22-1/2 degrees, 45 degrees, and 67-1/2 degrees to lamps; and (4) Zonal lumens stated numerically in 10 degree increments and at angles to lamps as described above.
   b. For area and roadway luminaires: (1) Isocandela charts; (2) Coefficients of utilization; and (3) IES roadway distribution classification.

4. After shop drawing approval, and prior to release for manufacturing, the Contract shall furnish one sample of each fixture on the fixture schedule and contract drawings for which sample requirement is noted. Sufficient time shall be allowed for thorough examination of the samples by the Lighting Consultant. Samples shall be complete, ready for hanging, energizing, and examining, and shall be shipped, prepaid by Contractor, to the Lighting Consultant, or as otherwise advised. Samples are not returnable, nor included in quantities listed for a project. Samples must be an actual working unit of materials to be supplied.

5. Submit details of air handling provisions for fixtures with supply and return air capabilities including, but not limited to: Airflow capacities, pressure drops, boot and connection types and other pertinent data.

6. Additional information as required in Section 260001, “Electrical General Provisions”.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver interior lighting fixtures individually wrapped in factory-fabricated fiberboard type containers.

B. Handle interior lighting fixtures carefully to prevent breakage, denting and scoring the fixture finish. Do not install damaged lighting fixtures.

C. Store interior lighting fixtures in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

A. General: Provide lighting fixtures, of the size, type and rating indicated on the Lighting Fixture Schedule, complete with, but not necessarily limited to, lamps, lampholders, reflectors, diffusers, louvers, wire guards, tube guards, ballasts, fuses, starters, and...
wiring. Fixtures shall be furnished with all required accessories and trim, including hold-
down clips, as required for a complete installation in the ceiling-type shown on the
Architectural Drawings.

1. Lighting equipment shall be complete, wired, and including supporting means, such as plaster frames, supports, hangers, canopies, sockets, holders; current or voltage modifiers, such as ballasts, starters; light control materials; specifically diffusers, louvers, lenses, reflectors and refractors; and lamps.

2. Lighting fixtures shall be designed for highest relative efficiency and service. Maintenance to be simple and relamping possible without use of special tools.

3. Lighting fixtures shall be constructed and installed in accordance with local building codes and shall bear label of approved testing agent. Materials shall be new and of best grade of approved manufacturing standards. Workmanship shall be of highest order.

4. Recessed fixtures shall be provided with frames appropriate construction encountered.

5. Ferrous fixture components shall receive treating to assure corrosion resistance and paint adherence. Aluminum parts, unless made of alloys having inherent corrosion resistance, shall be anodized or coated with oxidation-preventing treatment. Finish shall be baked enamel where color is indicated.

6. Plastic shall be acrylic.

B. General Fixture Construction:

1. All materials, accessories, and other related fixture parts shall be new and free from defects which in any manner may impair their character, appearance, strength, durability and function, and effectively protected from any damage or injury from the time of fabrication to the time of delivery and until final acceptance of the work.

2. Fabricate fixture enclosures with a minimum of No. 22 gauge cold rolled sheet steel. Enclosures may be constructed of other metals, provided they are equivalent in mechanical strength, and acceptable to the Engineer.

3. All sheet metal work shall be free from tool marks and dents, and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. All intersections and joints shall be formed true of adequate strength and structural rigidity to prevent any distortion during shipping, installation, and while in normal use.

4. Housings shall be so constructed that all electrical components are easily accessible and replaceable without removing fixtures from their mountings, or disassembly of adjacent construction.

5. All custom light fixtures shall be thoroughly tested in Manufacturer's shop prior to shipment to ensure mechanical and electrical integrity.

6. All fixtures shall be completely wired at the factory.

7. If ceiling system requires, each recessed and semi-recessed fixture shall be furnished with a mounting frame or ring compatible with the ceiling in which they are to be installed. The frames and rings shall be one piece or constructed with electrically-welded butt joints, and of sufficient size and strength to sustain the weight of the fixture.

8. Fixture to be sealed against light leaks between ceiling trims of recessed and semi-recessed lighting equipment and the ceilings. If fixture is used in partially transparent ceiling, fixtures to be sealed against light leaks above the ceiling line.
9. Yokes, brackets and supplementary supporting members needed to mount lighting fixtures to carrier channels or other suitable ceiling members shall be provided as required.

10. Fixtures for use outdoors or in areas designated as wet locations shall be suitably gasketed to prevent the entrance of moisture. Provide approved wire mesh screens for ventilation openings. Damp location fixtures to be of corrosion resistant parts and hardware.

11. In the application and mounting condition specified, fixtures and ballasts must operate within the temperature limits of their design and as specified by Underwriters' Laboratories, Inc.

12. Each lighting fixture which has a beam angle adjustment shall have reliable angle locking device capable of long and continuous use.

13. Each lighting fixture which has a lamp with an oval shape beam pattern shall contain a lamp orientation locking device which will insure that beam orientation is not disturbed during lamp replacement and fixture cleaning.

14. Each light fixture which has a spread lens shall contain lens orientation locking device which will insure that lens orientation is not disturbed during lamp replacement and fixture cleaning.

15. All lamp sockets in lighting fixtures shall be suitable for the specified lamps and shall be set so that lamps are positioned in optically correct relation to all lighting fixture components. If adjustable socket positions are provided, socket should be preset in factory for the specified lamp. If different socket positions are specified for various types of the same fixture, sockets shall be preset for each type, and cartons marked accordingly.

C. Reflectors and Trims:

1. Reflectors, reflector cones and visible trim of all lighting fixtures shall not be installed until completion of plastering, ceiling tile work, painting and general clean-up. They shall be carefully handled to avoid scratching or finger-printing and shall be, at the time of acceptance by the Owner, completely clean.

2. All Alzak parabolic cones shall be guaranteed against discoloration for a minimum of 10 years, and, in the event of premature discoloration, shall be replaced at the expense of the manufacturer for both materials and the cost of labor.

3. Aluminum reflectors shall be finished specular, semispecular, or diffuse as specified and shall meet or exceed Alzak specifications. Minimum requirements for reflector finishes for interior and exterior service shall be as follows:
D. Lenses:

1. Plastic for lenses and diffusers shall be formed of colorless 100% virgin acrylic as manufactured by Rohn & Haas, Dupont or as acceptable to the Engineer. The quality of the raw material must exceed IES, SPI, and NEMA Specifications by at least 100% which, as a minimum standard, shall not exceed a yellowness factor of 3 after 2,000 hours of exposure in the Fade-meter or as tested by an independent test laboratory. Acrylic plastic lenses and diffusers shall be properly cast, molded or extruded as specified, and shall remain free of any dimensional instability, discoloration, embrittlement, or loss of light transmittance for at least 15 years.

2. Glass used for lenses, refractors, and diffusers in incandescent and HID lighting fixtures shall be tempered for impact and heat resistance; the glass shall be crystal clear with a transmittance of not less than 88%. For exterior fixtures use tempered Borosilicate glass Corning #7740 or as acceptable to the lighting consultant. For fixtures with a radiant energy of 4.16 watts per square inch or greater, directly exposed to the elements and aimed above the horizontal, use Vycor glass.

3. Where optical lenses are used, they shall be free from spherical and chromatic aberrations and other imperfections which may hinder the functional performance of the lenses.

4. All lenses, louvers, or other light diffusing elements shall be removable, but positively held so that hinging or other normal motion will not cause them to drop out.

5. All lenses shall be clean and free of dust at the time of substantial completion.

E. Lamp Holders:

1. Incandescent:

2. Fluorescent:
   b. Contacts: Phosphor bronze.

3. High Intensity Discharge:
F. Finishes:

1. Painted Surfaces: Synthetic enamel, with acrylic, alkyd, epoxy, polyester, or polyurethane base, light stabilized, baked on at 350°F minimum, catalytically or photochemically polymerized after application.

2. White Finishes: Minimum of 85% reflectance.

3. Frames: Ceiling opening frames shall either be manufactured of nonferrous metal, or be suitably rustproofed after fabrication.

4. Selection: Unless otherwise noted, finishes shall be as selected by the Architect.

5. Undercoat: Except for stainless steel, provide ferrous metal surfaces with a five stage phosphate treatment or other acceptable base bonding treatment before final painting and after fabrication.

6. Unpainted Surfaces: Unpainted nonreflecting surfaces shall be satin-finished and coated with a baked-on clear lacquer to preserve the surface. Where aluminum surfaces are treated with an anodic process, the clear lacquer coating may be omitted.

7. Unpainted Aluminum Surfaces: Finish interior aluminum trims with an anodized coating of not less than 7 mg per square inch, of a color and surface finish as selected by the Architect. Finish exterior aluminum and aluminum trims with an anodized coating of not less than 35 mg per square inch, of a color and surface finish as selected by the Architect.

8. Porcelain Enamel Surfaces: Apply porcelain finishes smoothly. Finish shall be not less than 7.5 mils thick of non-yellowing, white, vitreous porcelain enamel with a reluctance of not less than 85%.

G. Fixture Fabrication:

1. General: Design components to allow for expansion and contraction for a minimum ambient temperature range of 150°F (37.8°C) without causing buckling, excessive opening of joints or over-stressing of welds and fasteners.

2. Sheet Metal Work: Form metalwork to required shapes and sizes with true curves, lines, and angles. All sheet metal work shall be free from tool marks and dents, and shall have accurate angles bent as sharp as compatible with the gauges of required metal. Form intersections and joints true with adequate strength and structural rigidity to prevent distortion after assembly. Provide necessary rebates, lugs and brackets for assembly of units. Use concealed fasteners wherever possible.

3. Welding: Comply with AWS for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded joints of all welded flux and dress on all exposed and contact surfaces.
4. Assembly: Accurately fit all parts of fixture. All joints in metal, not checked, shall be brazed and not soldered. Joints shall be invisible. Where screws are necessary for adjustment of applied ornament, they shall be concealed, as far as possible, and finished to match other metalwork. Mill joints to a tight, hairline fit. Cope or miter corner joints. Form joints exposed to weather to exclude water penetration. Assembled fixtures shall be well braced, and of adequate strength to resist sagging or deforming.

H. Glass:
1. Glassware shall be mechanically strong, properly annealed, and free from internal strain that might cause breakage. Where possible glassware shall be tempered for impact and heat resistance. Unless otherwise noted, all enclosing globes shall match glass of existing fixtures, or if none exists, glassware shall match approved prototype in size, contour, finish and general appearance. Supplied globes shall faithfully reproduce existing globes or approved prototypes in every way, having qualities equal to or better than the approved prototype without sacrifice of any other characteristics such as transparency or translucency and reflection/refraction properties. Glassware supplied shall be of consistently high quality and free from such imperfections as streaks, corns, stones, blisters, checks or other flaws that affect glassware strength or appearance.

2. Dimensional Tolerances of Glass: All other dimensions of supplied globes shall not vary more than 1% more or less than the respective dimension on the approved prototype. Tolerances for glass thickness shall be set by the Architect and adhered to by the contractor. Each unit of glassware supplied shall be identical to others of that type and faithful to the approved prototype.

3. All glass ornament in relief and globes shall be blown up fully in molds so as to faithfully replicate approved samples.

4. Where shown, etch, chase or carve ornament on globes as detailed.

5. Glass Overage: Furnish 10% additional in number of each size and kind of globe (or a minimum of two, whichever is greater).

I. Wiring:
1. Generally use SF-2 insulated wire for rewiring existing or new wire at replicated light fixture. SF-1 may be substituted in those locations where space will not permit the installation of SF-2 and where the load is 6 amps or less. Provide 600 volt insulation.

2. Factory-wire all fixtures. Provide leads no shorter than 1'-0" or as required to suit the project application.

J. Connections:
1. Fasteners: Furnish fasteners of basic metal and alloy, matching finished color and texture as metal being fastened, unless otherwise indicated. For steel and aluminum fixtures, all screws, bolts, nuts, and other fastening and latching hardware shall be cadmium or equivalent plated. For stainless steel fixtures, all hardware shall be stainless steel. For bronze fixtures, all hardware shall be bronze.

2. Welding Materials: Type and alloy of filler metal and electroodes as recommended by producer of metal to be welded, and as required for color match, strength and compatibility in the fabricated units.

K. Fixture Types:
1. Fluorescent Fixtures: Provide fluorescent fixtures of the type scheduled on the Lighting Fixture Schedule, complete with ballasts and lamps of the type, color, wattage and size scheduled.
   a. Provide fluorescent fixtures with heavy white lampholders with definite locking-in feature and contacts for proper lamp operation and life. Outdoor lampholders shall be neoprene gasketed and compression type. Sockets with open-circuit voltage over 300 volts to be safety type and designed to open the supply circuit on lamp removal.
   b. Fixture body parts, comprising fixture housing, reflectors, wire channels, end plates, ballast housings, and similar body parts, shall be made of extruded aluminum, galvanized stampings, or bonderized steel, as indicated. Housing end plates, socket bridges, reflectors, wiring channels and ballast covers shall be die formed of not less than No. 22 gauge cold rolled steel unless specified otherwise. Mount lamps on rapid-start circuits within one inch (1") of grounded metal, one inch (1") wide minimum and as long as the lamp. Wireways shall have adequate wiring space, accessible after fixture installation. Construct fixtures so that ballast may be serviced or replaced without removal of fixture housing from adjacent construction. Housing shall be adequately ventilated where required. Hardware shall have rustproof finish. Fixture bodies shall be painted after fabrication.
   c. Temperatures around ballast and in fixture housing shall not exceed 90°C with ambient room temperature at 27°C.
   d. Lighting fixtures shall have continuous light-seal gaskets seated in such manner as to prevent any light leaking through any portion or around any edge of the trim frame. Other sealing methods shall be individually reviewed.
   e. Diffusers shall be framed in hinged continuous assembly, except where frameless units are indicated. Frameless units shall be removable without tools and opened or closed by hand pressure. Diffuser frame latches shall be spring-loaded or cam-operated.
   f. Fluorescent fixture lenses, where required, shall be 100% extruded virgin acrylic, prismatic-type, nominal 0.125" thick, unless specified otherwise. Provide a minimum of eight hold-down lens retaining clips for troffers utilizing framed diffuser lenses.
   g. Fluorescent fixtures in continuous rows shall be supplied with all fixture couplings, chase nipples, and other accessories recommended by the manufacturer for continuous row installation.
   h. Fluorescent troffers shall be shipped prelamped, unless noted otherwise.
   i. Parabolic louver fluorescent troffers shall be shipped with a plastic bag or film to protect the louvers from site conditions. Louver protection shall not be removed until the space where the fixture is installed is complete.
   j. Supply air-type fluorescent fixtures shall be provided with adjustable air pattern control blades.
   k. Lay-in fixtures shall be provided with hold-down clips per the NEC, minimum two clips per fixture.

2. HID Fixtures: Provide HID fixtures as scheduled on the Lighting Fixture Schedule, complete with fused ballast, lamps of the type, color, wattage, and size scheduled, or as specified by the lighting fixture manufacturer.
a. On open metal halide fixtures, provide a shield below the lamp to provide protection from lamp breakage at the end of lamp life.

b. Size and type of fuse shall be as recommended by the ballast manufacturer. Holders shall be mounted inside the fixture junction box for recessed fixtures, inside enclosed fixtures and inside pole base handholes of pole-mounted fixtures. Holders installed in damp or wet locations shall be waterproof. Holders installed in bollards and pole bases shall be of a breakaway disconnect design.

3. Incandescent Fixtures: Provide incandescent fixtures as scheduled on the Lighting Fixture Schedule, complete with lamps of the type, color, wattage, and size scheduled.

   a. Provide recessed incandescent fixtures with trim rings compatible with the ceiling material where fixture is to be installed. Incandescent fixtures shall be prewired equipped with integral thermal protection. Incandescent lighting fixtures shall be appropriately listed and labeled by Underwriters’ Laboratories, Inc. for their final installation, i.e., damp or wet locations, etc.

   b. Recessed fixtures shall be designed and installed to eliminate light leakage.

   c. Fixtures intended for use with medium or mogul base lamps shall use porcelain sockets, wire with (minimum) No. 18, 150°C rated wire and in accordance with the applicable NEC requirements. Fixtures intended for recessed mounting shall be furnished with not less than 4' of approved fixture wire. Lighting fixtures with PAR or similar lamps shall be wired with approved silicone or other approved fixture wire, suitable and labelled for the purpose.

   d. Lampholders to be high grade porcelain, Edison screw-type, medium size and of the highest class and quality with socket of nickel-plated brass prelubricated with silicone compound. Provide mogul-type lampholders for lamps of 300 watt rating and over. Sockets shall be provided with an approved arrangement to securely set and lock socket into lighting fixture.

   e. For recessed incandescent fixtures where junction box is required, shall be accessible when fixture is removed. Connect to conduit system with flexible conduit containing #14 (minimum) fixture wire.

   f. Aluminum reflectors shall be Alzak (finish as selected) or as authorized, and not less than 0.057" thick, unless specified otherwise.

   g. Incandescent lighting fixtures utilizing tungsten halogen sources shall be designed and constructed so that lamp seal temperatures do not exceed 350°C at an ambient temperature of 25°C when tested in accordance with UL Standard #57 and shall maintain an operating bulb wall temperature of approximately 600°C and not less than 250°C.

   h. Lead wires for fixtures utilizing tungsten halogen sources shall be rated for not less than 200°C operation, but shall be rated for 250°C if expected temperature conditions warrant.

   i. Temperature on reflectors shall not exceed 205°C at any point.

   j. All fixtures specified for recessing in ceilings shall be supplied with prewired junction boxes.
4. Lighting Track: Provide a complete track lighting installation as scheduled on the Lighting Fixture Schedule, complete with fixture heads as shown or scheduled and lamps of the type, color, wattage and size scheduled.

a. Lighting track shall be single circuit light track assembly unless specified otherwise. It shall consist of an outer housing with two electrical conductors, and with suitable insulation between the conductors and the housing. The conductors to be tin-plated copper and the insulation shall be of high temperature vinyl. The housing shall have a moment of inertia of not less than 0.160" and shall be made of a noncorrosive material such as an aluminum extrusion of Alloy 6063 T5.

b. Grounding may be provided by the housing or by other means, and in the process of installing a fixture on the track, the grounding connection shall be automatically completed before electrical conductor contact occurs. Maximum outside dimensions of the housing shall be 1-5/8" high x 1-7/8" wide with a continuous open slot on the ceiling line not wider than 3/4".

c. The track assembly shall be rated at not less than 50 amperes at 300 volts. The insulation shall be suitable and approved for temperatures resulting from the use of several track fixtures in close array with Q250 PAR 38 lamps. A special electrical feed box shall be furnished for attachment to any location along the track, with spring mounted coverplate fitting the box neatly and mounting flush with the conductors.

d. The track shall be spliced in such a way that it is not obviously visible where the electrical and mechanical connection occurs.

e. Specially designed splice bars shall align and connect two runs of track.

f. Two push-in continuity jumpers shall be supplied to maintain electrical contact at a splice location. Track runs to be provided with 8" long #10 teflon leads.

g. The track shall incorporate means for secure mechanical attachment and simultaneous electrical feed of lighting fixtures equipped with the necessary attachment plug devices.

h. Recessed track as installed shall be absolutely flush with finished ceiling plane and absent of any gaps between ceiling material and aluminum housing. Contractor shall be responsible for making sure that recessed track integrates properly into ceiling construction and according to manufacturer's recommendations. This includes having appropriate ceiling assembly and finish material thickness.

5. Cold Cathode Lighting: Provide a complete cold cathode lighting installation as scheduled on the Lighting Fixture Schedule and as shown on the Architectural and Electrical Drawings and Details. It shall be manufactured in entirety, including lamps, lampholders and ballasts, by National Cathode Corp., or approved equal.

a. Lamps shall be mounted in a straight electrode configuration and shall produce 440 lumens per foot when operating at 200 ma, and shall not depreciate more than 20% after 10,000 hours of operation.

b. Lamps shall be made from 1 inch (1") diameter lead glass halo-phosphor coated and baked, with heavy duty coated electrodes and shall be fabricated to the shapes and sizes called for in the Architectural details, and shall have adjustable snap-on lamp reflectors.
c. Lampholders shall be right-angle, straight electrode type, UL-listed, and of white glazed porcelain with spring bronze clip contacts to give good electrical contact and support the lamps securely.

d. Ballasts required for the cold cathode lamps shall be remotely located as directed by the Architect. The ballasts shall be UL-listed, HPF, 118 volt, 60 Hz, 200 ma, for cold weather operation.

e. Installation of lamps, lampholders, secondary feeds, and ballasts shall be in strict accordance with the intent of the contract drawings and the approved shop drawings of the cold cathode manufacturer. The Contractor shall install the lampholders so that all lamps make secure electrical contact.

f. Circuit breakers controlling the circuits feeding the cold cathode ballasts shall be capable of being locked in the open position.

g. Shop drawings shall include scale plans and details showing the method of installation of lampholders, lamps, reflectors, ballasts, and secondary feeds, as well as a complete bill of materials. The shop drawings shall show the exact locations of the lampholders and lamp shapes and lengths, and six copies shall be supplied, to be incorporated in the Maintenance Manuals.

h. The following manufacturer information shall be provided by the Contractor within 60 days of signing of the contract: name of manufacturer, and if other than National Cathode Corp., list of previous jobs using one inch (1") diameter lamps operating at 200 ma.

6. Exit Signs: Provide exit signs as scheduled on the Lighting Fixture Schedule. Exit lighting fixtures shall meet the requirements of all applicable federal, state, and local codes.

   a. Exit sign battery packs shall meet all specified requirements for Fluorescent Emergency Battery Backup Units as specified in Paragraph 2.01/N.

L. Ballasts:

   1. Energy Saving Electronic Ballasts - Indoor Fluorescent: Provide UL-listed, low noise, high power factor, rapid start, Class P, thermally protected, encased solid state energy saving ballasts for indoor lighting fixtures. Ballasts shall operate at a frequency between 20 and 35 kHz and shall produce no visible lamp flicker. Ballasts shall operate lamps on parallel or series circuits and shall deliver normal lamp life. Lamp failure shall not affect ballast life. Ballasts shall comply with all applicable FCC and NEMA standards concerning EMI and RFI emissions and shall meet applicable ANSI standards related to harmonic distortion and surge suppression. Provide ballasts with a maximum power input wattage of 60 watts when installed in a surface-mounted, 2-lamp, strip fixture with standard F34 lamps. Ballast power factor shall be 90% or greater and input current harmonic content shall not exceed 10%. Electronic ballasts shall be Advance or an approved equal by Valmont, MagnaTek, Motorola or Universal. Ballasts shall be mounted in fixtures so as to provide maximum sound attenuation.

M. Lamps:

   1. General: Provide lamps of the wattage, type, color, and reflector lamps with type of beams indicated, as shown, and as scheduled. Provide extended service lamps that are inside frosted. Provide energy saving lamps for all fluorescent fixtures installed in indoor conditioned locations, unless otherwise noted. Incandescent and tungsten halogen lamps shall not be operated, other than for
initial testing, prior to final inspection, or shall be replaced immediately prior to final inspection.

2. Maintenance Stock: Furnish a stock of replacement lamps in the original cartons or packing sleeves, amounting to 10% (but not less than two lamps in each case) of each type and size lamp used in each fixture type. Deliver replacement stock as directed to Owner’s storage space.

N. Fluorescent Emergency Battery Backup Unit:

1. General: Provide fluorescent lighting fixtures with emergency battery backup and integral emergency (self-powered) fluorescent power system for each fixture as shown or scheduled on the Drawings. The integral fluorescent emergency power system shall consist of a charger, high frequency inverter, voltage disconnect and a sealed nickel cadmium battery designed for high temperature operation. Provide battery unit with self test feature.

2. Operation: During normal operation, when switched ac is present, the fixture will be fully illuminated by means of the regular ballast. At the same time, the emergency ballast is supplied with nonswitched ac, which transforms and rectifies into a low dc voltage to recharge the battery and maintain it in a fully charged condition. When the nonswitched ac fails, a solid state voltage sensor instantly turns on a high frequency inverter which illuminates one lamp in the fixture at reduced light output for a minimum of 90 minutes. At the end of the rated time a low voltage sensor disconnects the battery to prevent over discharging. When the ac nonswitched returns, the inverter switches off and the battery starts recharging.

3. Battery: (Internal) Sealed Nickel Cadmium - specially constructed to withstand the high temperatures of ballast compartments. 15 year life expectancy; 5 year unconditional and additional 5 year pro rata warranty. Batteries shall not require periodic cycling or full discharge upon use to maintain full battery capacity.

4. Power Requirements: 120 or 277 volts, 60 Hz, for the specified lighting fixtures as indicated on the Lighting Fixture Schedule.

5. Output: Suitable for one F40 fluorescent tube, rapid or instant start, operating at approximately 20% of its nominal light output.

6. Transfer: Solid state-type, automatically and instantly energizes lamp load upon failure of the ac supply. Battery protection circuit automatically shuts down lamp load when battery reaches full discharge.

7. Charger: All solid state, recharges battery in 12 to 24 hours, current limited and short circuit proof.

8. Inverter: All solid state, 87% minimum efficiency uses a fully isolated and protected electronic oscillator to produce an inaudible high frequency output. Inverter will ignite lamp which has burned out under normal conditions.

9. Self-Test: The diagnostic circuit continually monitors battery voltage and charging current, and will communicate a fault by flashing the status indicator lamp. An automatic discharge test is also performed for 30 seconds, every 30 days and for 90 minutes every 12 months.

10. Enclosure: 20 gauge steel painted black baked enamel. Mounts inside the fixture adjacent to normal ballast. Flying leads provided for connections to external test switch and pilot light which is supplied with the unit. Test switch and pilot light shall be furnished to the lighting fixture manufacturer for installation and connection into the fixture by the lighting fixture manufacturer.

11. Warranty: All electronics shall carry a 3 year unconditional warranty. The manufacturer of the unit shall provide three full cycles of discharge and recharge before shipment and shall certify that the testing has been done.
PART 3 - EXECUTION

3.1 INSTALLATION:

A. General:
   1. Install lighting fixtures of the types indicated, where shown, and at the indicated heights in accordance with the fixture manufacturer's written instructions and recognized industry practices to ensure that the fixtures comply with the requirements and serve the intended purposes. Do not scale drawings for exact location of the lighting fixtures. In general, refer to the architectural reflected ceiling plans for proper locations of lighting fixtures. Fixtures shall exactly fit the type of ceiling system scheduled for the space.
   2. Fixtures shown on the fixture schedule to be recessed shall be complete with plaster frames, mounting yokes, rod hangers, etc., and/or any other accessories required to fit the fixture to the ceiling construction. However, where ceiling system cannot maintain said support, fixture supports shall be provided and rigidly attached to the structural members of the building capable of carrying the weight of the fixture plus 200 pounds at each support without sagging. Provide the necessary supports for hangers located between structural members.

B. Standards: Comply with NEMA standards, applicable requirements of the NEC pertaining to installation of interior lighting fixtures, and with applicable portions of the NECA's "Standard of Installation".

C. Connection: All individual lay-in fluorescent fixtures in suspended ceilings, shall be connected back to the associated lighting grid outlet box by wire in 3/8" (minimum) flexible metallic conduit fixture-tails in lengths not to exceed 72"; or by Type MC cable fixture-tails where permitted by the local authority having jurisdiction, in lengths not to exceed 8'. All fixture tails shall have ground wire pulled with conductors.

D. Mounting: Fasten fixtures securely to the indicated structural support members of the building. Provide separate supports or mounting clips for all recessed ceiling-mounted lighting fixtures in accordance with the NEC. Check to ensure that solid pendant fixtures are plumb.

E. Appurtenances: Install each fixture properly and safely. Furnish and erect hangers, rods, mounting brackets, supports, frames, and other equipment required.

F. Coordination: Furnish lighting fixtures complete with appurtenances required for the proper, safe and distortion-free installation in the various surfaces in which they appear. Determine surface types from the Architectural drawings.

G. Instructions: Each lighting fixture shall be packaged with complete instructions and illustrations showing how to install. Install lighting fixtures in strict conformance with manufacturer's recommendations and instructions.

H. Continuous Row Fixtures: Rigidly align all continuous rows of lighting fixtures for true in-line appearance.

I. Pendant Fixtures: Install pendant lighting fixture plumb and at a height above the finished floor as specified in the drawings. In cases where conditions make this impractical, refer to the Architect for a decision. Use ball aligners and canopies on pendant fixtures unless noted otherwise.

J. Suspended Fixtures:
   1. Fixture studs shall be provided in all outlet boxes from which fixtures are suspended. Fixtures shall not be suspended by means of cover or canopy.
screws. Canopies shall completely cover the ceiling opening of all ceiling fixtures except lay-in fixtures in T-bar construction, and trimless fixtures.

2. Surface-mounted lighting fixtures (i.e. exit lights, etc.) are installed on lay-in panels in T-bar ceiling construction, the outlet boxes shall be rigidly supported to the ceiling system using metal channels spanning perpendicular across the T-bars and securely attached to each side of the outlet box.

K. **Outlet Boxes:** The locations indicated for outlet boxes of lighting fixtures are diagrammatic. Outlets shall be located as required to coincide with suspension hangers where they occur and with structural and architectural elements of the building and shall be located in accordance with the Architectural Reflected Ceiling Plan.

L. **Fixture Designations:** If a fixture-type designation is omitted, furnish fixture of the same type as shown for rooms of similar usage. Verify with Engineer before purchase and installation.

M. **Installation Sequence:** Do not install fixtures or such parts as finishing plates and trims for recessed fixtures until all plastering and painting that may mar fixture finishes has been completed. Install reflector cones, baffles, aperture plates, light controlling elements for air handling fixtures, and decorative elements after completion of ceiling tiles, painting and general cleanup.

N. **Mechanical Rooms:** Lighting fixture locations in mechanical and electrical equipment rooms are approximate. Coordinate mounting height and location of lighting fixtures to clear mechanical, electrical and plumbing equipment and to illuminate adequately meters, gauges and equipment. Support all lighting fixtures independently of ductwork, piping and their supports.

O. **Concealment:** Whenever a fixture or its hanger canopy is applied to a surface mounted outlet box, a finishing ring shall be utilized as necessary to conceal the outlet box.

P. **Wire Guards/Tube Guards:** Wire guards or tube guards shall be provided for all fixtures with exposed lamps where installed in mechanical/electrical spaces; in all locations below 8'-0" above finished floor; [and where lamps are exposed to damage.

Q. **Fluorescent Emergency Backup Units:** For nonswitched applications connect ac input to switched and unswitched unit inputs, unless noted otherwise on Drawings. For switched applications provide a switched ac input to the unit switched input and a nonswitched ac input to the unit nonswitched input.

### 3.2 Aiming and Adjustment:

A. All adjustable lighting units shall be aimed, focused, locked, etc., by the Contractor under the supervision of the Lighting Consultant. The Lighting Consultant shall indicate the number of crews (foreman and apprentice) required. All aiming and adjusting shall be carried out after the entire installation is complete.

B. All ladders, scaffolds, etc. required for aiming and adjustment shall be furnished by the Contractor at the direction of the Lighting Consultant. As aiming and adjustment is completed, locking setscrews and bolts and nuts shall be tightened securely.

C. Units shall be focused during the normal working day, where possible. However, where daylight interferes with precise focusing, aiming shall be accomplished at night.

### 3.3 Cleanup:

A. At the time of final acceptance by the Owner, all lighting fixtures shall have been thoroughly cleaned with materials and methods recommended by the manufacturers, all
broken parts shall have been replaced, and all lamps shall be operative. Replace blemished, damaged, or unsatisfactory fixtures as directed by Architect.

3.4 MAINTENANCE:

A. The Contractor shall be responsible for obtaining from his supplying lighting manufacturers, for each type of lighting fixture, a recommended maintenance information which shall be included in the Project Operating and Maintenance Manuals. Minimum information shall include:
   1. Tools required.
   2. Types of cleaners to be used.
   3. Replacement parts identification list.
   4. Final as-built shop drawings.

3.5 WARRANTY:

A. The Contractor shall warrant all fixtures, their finishes, and all of their component parts, except ballasts, to be free from defects for a period of one year from date of acceptance, if operated within rated voltage range. Ballasts shall be warranted for 2 years. Fixture installation shall be warranted for one year from the date of acceptance of the installation. During the warrantee period, repair or replacement of defective materials and/or repair of faulty workmanship or installation shall be provided at no cost to the Owner within 10 days of written notice of the defects as recorded and submitted by the Owner and/or Architect.

3.6 TESTING:

A. General: Upon completion of installation of lighting fixtures and after building circuitry has been energized, apply electrical energy to demonstrate proper operation of lighting fixtures and controls. When possible, correct malfunctioning units at the site, then retest to demonstrate proper operation; otherwise, remove and replace with new units and proceed with retesting.

B. Lamps: Install all new incandescent lamps just prior to final inspection. Fluorescent and HID lamps may be utilized in the final finishing of the building. Replace gaseous discharge lamps that are defective, show discolorations, or have exceeded more than 1/3 of their rated life, as per Engineer/Owner's records, with new lamps for final inspection.

C. Preinspection Tasks: Immediately before final inspection, thoroughly clean all fixtures inside and out, including plastics and glassware, adjust all trim to properly fit adjacent surfaces, replace broken or damaged parts and lamp, and test all fixtures for electrical and mechanical operation. Any fixtures or parts of fixtures, which have begun to show signs of rust or corrosion at the time of completion of the job, shall be removed and replaced with properly protected metal parts.

END OF SECTION 265100
PART 1 - GENERAL

1.1 RELATED DOCUMENTS:
A. The Conditions of the Contract and applicable requirements of Divisions 0 and 1 and Section 26001, "Electrical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:
A. Work Included: The extent of lighting fixture work is as shown and scheduled, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications. All materials, accessories, and any other equipment necessary for the complete and proper installation of all lighting fixtures included in this Contract shall be furnished by the Contractor.

B. Types: The types of lighting fixtures required for the project may include, but are not limited to:
   1. LED Fixtures.
   2. Pole-mounted lighting fixtures.

C. Applications: The applications of lighting fixtures required for the project include, but are not limited to:
   1. Exterior lighting.
   2. Roadway and Parking lighting.
   3. Outdoor area lighting.

D. Specifications and scale drawings are intended to convey the salient features, function and character of the fixtures only, and do not undertake to illustrate or set forth every item or detail necessary for the work.

E. Minor details, not usually indicated on the drawings nor specified, but that are necessary for the proper execution and completion of the fixtures, shall be included, the same as if they were herein specified or indicated on the Drawings.

F. The Owner shall not be held responsible for the omission or absence of any detail, construction feature, etc. which may be required in the production of the fixtures. The responsibility of accurately fabricating the fixtures to the fulfillment of this specification rests with the Contractor.

1.3 STANDARDS:
A. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:
   2. NEMA WD1 General-Purpose Wiring Devices.

1.4 QUALITY ASSURANCE:
A. The light fixtures listed on the schedule are basis of design only and are not intended to restrict open and competitive bidding. Contact the following manufacturer’s representatives for alternate light fixture packages:
   b. Sharon Hidalgo, Lesco Lighting + Controls, 713-923-7781
   c. Jason Peterson, Putterman Scharck, 713-664-7111

B. Alternate packages shall include photometric calculations for the project including egress lighting calculations to ensure design light levels are met.

C. The Architect will review all submitted alternate light fixtures for conformance to design aesthetic and appearance and will reject fixtures that in their judgement do not comply.

D. Manufacturers: Provide products produced by manufacturers as shown or scheduled for each type of lighting fixture. Identification in the fixture schedule by means of manufacturers’ names and catalog numbers is to facilitate establishment of basic features, construction and performance standards. Any substitutions must, in the opinion of the Engineer, meet or exceed these standards. Provide products complying with these specifications and produced by one of the following for drivers and LED light sources:
   1. Light Fixtures
      a. Manufacturers as listed or scheduled on the Drawings.
   2. Driver Manufacturers:
      b. Universal/Magnetek.
      c. Osram Sylvania.
      d. Lutron Electronics.
   3. LED Light Sources:
      a. Cree.
      b. General Electric Company.
      c. Osram Sylvania.

E. Conformance: Fixtures shall be manufactured in strict accordance with the Drawings and Specifications.

F. Codes: Materials and installation shall be in accordance with the latest revision of the National Electrical Code and any applicable federal, state, and local codes and regulations.

G. UL-Listing: All fixtures shall be manufactured in strict accordance with the appropriate and current requirements of the Underwriters’ Laboratories, Inc. "Standards for Safety," and others as they may be applicable. A UL-listing shall be provided for each fixture type, and the appropriate label or labels shall be affixed to each fixture in a position concealing it from normal view.

H. Warranty: All LED light sources and drivers shall be provided with a 5 year warranty from the date of project acceptance.
I.5 SUBMITTALS:

A. Shop Drawings submittals shall include, but not be limited to, the following:

1. Submit manufacturer’s data on exterior lighting fixtures in booklet form, with separate sheet for each fixture, assembled by fixture “type” in alphabetical order, with the proposed fixture and accessories clearly labeled. Driver and LED light source product data shall accompany fixture submittals.

2. Submit LM-80 lumen depreciation test results and L70 rated life test results for each type of LED source package, array or module being submitted for the project.

3. Submit dimensioned drawings and performance data including coefficients of utilization, candela distribution, spacing to mounting height ratio, efficiency and visual comfort probability.

4. Submit details of fixture mounting including frames, trims, canopies, support requirements, and other data pertinent to fixture installation.

5. Submit complete photometric data for each fixture, including optical performance and efficiency rendered by independent testing laboratory developed according to methods of U.S.A. Illuminating Engineering Society as follows:
   a. For area and roadway luminaires: (1) Isocandela charts; (2) Coefficients of utilization; and (3) IES roadway distribution classification.
   b. Supply photometric data as described above for any fixture offered in substitution for a specified fixture.

6. After shop drawing approval, and prior to release for manufacturing, the Contract shall furnish one sample of each fixture on the fixture schedule and contract drawings for which sample requirement is noted. Sufficient time shall be allowed for thorough examination of the samples by the Lighting Consultant. Samples shall be complete, ready for hanging, energizing, and examining, and shall be shipped, prepaid by Contractor, to the Lighting Consultant, or as otherwise advised. Samples are not returnable, nor included in quantities listed for a project. Samples must be an actual working unit of materials to be supplied.

7. Submit details of air handling provisions for fixtures with supply and return air capabilities including, but not limited to: Airflow capacities, pressure drops, boot and connection types and other pertinent data.

8. Additional information as required in Section 26 00 01, “Electrical General Provisions”.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver exterior lighting fixtures individually wrapped in factory-fabricated fiberboard type containers.

B. Handle exterior lighting fixtures carefully to prevent breakage, denting and scoring the fixture finish. Do not install damaged lighting fixtures.

C. Store exterior lighting fixtures in a clean, dry space and protect from the weather.
A. General: Provide lighting fixtures, of the size, type and rating indicated on the Lighting Fixture Schedule, complete with, but not necessarily limited to, LED light sources, reflectors, diffusers, louvers, wire guards, tube guards, ballasts, fuses, starters, and wiring. Fixtures shall be furnished with all required accessories and trim, including hold-down clips, as required for a complete installation in the ceiling-type shown on the Architectural Drawings.

1. Lighting equipment shall be complete, wired, and including supporting means.
2. Lighting fixtures shall be designed for highest relative efficiency and service.
3. Lighting fixtures shall be constructed and installed in accordance with local building codes and shall bear label of approved testing agent. Materials shall be new and of best grade of approved manufacturing standards. Workmanship shall be of highest order.
4. Recessed fixtures shall be provided with frames appropriate construction encountered.
5. Ferrous fixture components shall receive treating to assure corrosion resistance and paint adherence. Aluminum parts, unless made of alloys having inherent corrosion resistance, shall be anodized or coated with oxidation-preventing treatment. Finish shall be baked enamel where color is indicated.
6. Plastic shall be acrylic.
7. All exterior light fixtures shall be UL labeled for damp or wet locations as applicable to the fixture construction and installation location.

B. General Fixture Construction:

1. All materials, accessories, and other related fixture parts shall be new and free from defects which in any manner may impair their character, appearance, strength, durability and function, and effectively protected from any damage or injury from the time of fabrication to the time of delivery and until final acceptance of the work.
2. Fabricate fixture enclosures with a minimum of No. 22 gauge cold rolled sheet steel. Enclosures may be constructed of other metals, provided they are equivalent in mechanical strength, and acceptable to the Engineer.
3. All sheet metal work shall be free from tool marks and dents, and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. All intersections and joints shall be formed true of adequate strength and structural rigidity to prevent any distortion during shipping, installation, and while in normal use.
4. Housings shall be so constructed that all electrical components are easily accessible and replaceable without removing fixtures from their mountings, or disassembly of adjacent construction.
5. All custom light fixtures shall be thoroughly tested in Manufacturer's shop prior to shipment to ensure mechanical and electrical integrity.
6. All fixtures shall be completely wired at the factory.
7. If ceiling system requires, each recessed and semi-recessed fixture shall be furnished with a mounting frame or ring compatible with the ceiling in which they are to be installed. The frames and rings shall be one piece or constructed with electrically-welded butt joints, and of sufficient size and strength to sustain the weight of the fixture.
8. Fixture to be sealed against light leaks between ceiling trims of recessed and semi-recessed lighting equipment and the ceilings. If fixture is used in partially transparent ceiling, fixtures to be sealed against light leaks above the ceiling line.

9. Yokes, brackets and supplementary supporting members needed to mount lighting fixtures to carrier channels or other suitable ceiling members shall be provided as required.

10. Fixtures for use outdoors or in areas designated as wet locations shall be suitably gasketed to prevent the entrance of moisture. Provide approved wire mesh screens for ventilation openings. Damp location fixtures to be of corrosion resistant parts and hardware.

11. In the application and mounting condition specified, fixtures and ballasts must operate within the temperature limits of their design and as specified by Underwriters' Laboratories, Inc.

12. Each lighting fixture which has a beam angle adjustment shall have reliable angle locking device capable of long and continuous use.

13. Each lighting fixture which has a spread lens shall contain a lamp orientation locking device which will insure that lens orientation is not disturbed during fixture cleaning and service.

14. Each light fixture which has a spread lens shall contain lens orientation locking device which will insure that lens orientation is not disturbed during lamp replacement and fixture cleaning.

15. All lamp sockets in lighting fixtures shall be suitable for the specified lamps and shall be set so that lamps are positioned in optically correct relation to all lighting fixture components. If adjustable socket positions are provided, socket should be preset in factory for the specified lamp. If different socket positions are specified for various types of the same fixture, sockets shall be preset for each type, and cartons marked accordingly.

C. Reflectors and Trims:

1. Reflectors, reflector cones and visible trim of all lighting fixtures shall not be installed until completion of plastering, ceiling tile work, painting and general clean-up. They shall be carefully handled to avoid scratching or finger-printing and shall be, at the time of acceptance by the Owner, completely clean.

2. All Ano-Brite (Alzak) parabolic cones shall be guaranteed against discoloration for a minimum of 10 years, and, in the event of premature discoloration, shall be replaced at the expense of the manufacturer for both materials and the cost of labor.

3. Aluminum reflectors shall be finished specular, semispecular, or diffuse as specified and shall meet or exceed Ano-Brite (Alzak) specifications. Minimum requirements for reflector finishes for interior and exterior service shall be as follows:

<table>
<thead>
<tr>
<th>DESCRIPTION OF SERVICE</th>
<th>MINIMUM WEIGHT OF COATING MG. PER SQUARE INCH</th>
<th>MINIMUM PERCENT REFLECTANCE</th>
<th>MINIMUM PERCENT REFLECTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exterior industrial and commercial reflector not protected</td>
<td>10</td>
<td>78</td>
<td>75</td>
</tr>
<tr>
<td>Exterior marine service reflector not protected</td>
<td>13</td>
<td>78</td>
<td>65</td>
</tr>
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</table>
D. **Lenses:**

1. Plastic for lenses and diffusers shall be formed of colorless 100% virgin acrylic as manufactured by Dow Chemical Company (Rohn & Haas), Dupont or as acceptable to the Engineer. The quality of the raw material must exceed IES, SPI, and NEMA Specifications by at least 100% which, as a minimum standard, shall not exceed a yellowness factor of 3 after 2,000 hours of exposure in the Fade-meter or as tested by an independent test laboratory. Acrylic plastic lenses and diffusers shall be properly cast, molded or extruded as specified, and shall remain free of any dimensional instability, discoloration, embrittlement, or loss of light transmittance for at least 15 years.

2. Glass used for lenses, refractors, and diffusers in incandescent and HID lighting fixtures shall be tempered for impact and heat resistance; the glass shall be crystal clear with a transmittance of not less than 88%. For exterior fixtures use tempered Borosilicate glass Corning #7740 or as acceptable to the lighting consultant. For fixtures with a radiant energy of 4.16 watts per square inch or greater, directly exposed to the elements and aimed above the horizontal, use Vycor glass.

3. Where optical lenses are used, they shall be free from spherical and chromatic aberrations and other imperfections which may hinder the functional performance of the lenses.

4. All lenses, louvers, or other light diffusing elements shall be removable, but positively held so that hinging or other normal motion will not cause them to drop out.

5. All lenses shall be clean and free of dust at the time of substantial completion.

E. **Finishes:**

1. **Painted Surfaces:** Synthetic enamel, with acrylic, alkyd, epoxy, polyester, or polyurethane base, light stabilized, baked on at 350°F minimum, catalytically or photochemically polymerized after application.

2. **White Finishes:** Minimum of 85% reflectance.

3. **Frames:** Ceiling opening frames shall either be manufactured of nonferrous metal, or be suitably rustproofed after fabrication.

4. **Selection:** Unless otherwise noted, finishes shall be as selected by the Architect.

5. **Undercoat:** Except for stainless steel, provide ferrous metal surfaces with a five stage phosphate treatment or other acceptable base bonding treatment before final painting and after fabrication.

6. **Unpainted Surfaces:** Unpainted nonreflecting surfaces shall be satin-finished and coated with a baked-on clear lacquer to preserve the surface. Where aluminum surfaces are treated with an anodic process, the clear lacquer coating may be omitted.

7. **Unpainted Aluminum Surfaces:** Finish interior aluminum trims with an anodized coating of not less than 7 mg per square inch, of a color and surface finish as selected by the Architect. Finish exterior aluminum and aluminum trims with an anodized coating of not less than 35 mg per square inch, of a color and surface finish as selected by the Architect.

8. **Porcelain Enamel Surfaces:** Apply porcelain finishes smoothly. Finish shall be not less than 7.5 mils thick of non-yellowing, white, vitreous porcelain enamel with a reluctance of not less than 85%.
F. **Fixture Fabrication:**

1. **General:** Design components to allow for expansion and contraction for a minimum ambient temperature range of 150°F (37.8°C) without causing buckling, excessive opening of joints or over-stressing of welds and fasteners.

2. **Sheet Metal Work:** Form metalwork to required shapes and sizes with true curves, lines, and angles. All sheet metal work shall be free from tool marks and dents, and shall have accurate angles bent as sharp as compatible with the gauges of required metal. Form intersections and joints true with adequate strength and structural rigidity to prevent distortion after assembly. Provide necessary rebates, lugs and brackets for assembly of units. Use concealed fasteners wherever possible.

3. **Welding:** Comply with AWS for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded joints of all welded flux and dress on all exposed and contact surfaces.

4. **Assembly:** Accurately fit all parts of fixture. All joints in metal, not checked, shall be brazed and not soldered. Joints shall be invisible. Where screws are necessary for adjustment of applied ornament, they shall be concealed, as far as possible, and finished to match other metalwork. Mill joints to a tight, hairline fit. Cope or miter corner joints. Form joints exposed to weather to exclude water penetration. Assembled fixtures shall be well braced, and of adequate strength to resist sagging or deforming.

G. **Glass:**

1. Glassware shall be mechanically strong, properly annealed, and free from internal strain that might cause breakage. Where possible glassware shall be tempered for impact and heat resistance. Unless otherwise noted, all enclosing globes shall match glass of existing fixtures, or if none exists, glassware shall match approved prototype in size, contour, finish and general appearance. Supplied globes shall faithfully reproduce existing globes or approved prototypes in every way, having qualities equal to or better than the approved prototype without sacrifice of any other characteristics such as transparency or translucency and reflection/refraction properties. Glassware supplied shall be of consistently high quality and free from such imperfections as streaks, corns, stones, blisters, checks or other flaws that affect glassware strength or appearance.

2. **Dimensional Tolerances of Glass:** All other dimensions of supplied globes shall not vary more than 1% more or less than the respective dimension on the approved prototype. Tolerances for glass thickness shall be set by the Architect and adhered to by the contractor. Each unit of glassware supplied shall be identical to others of that type and faithful to the approved prototype.

3. All glass ornament in relief and globes shall be blown up fully in molds so as to faithfully replicate approved samples.

4. Where shown, etch, chase or carve ornament on globes as detailed.

5. **Glass Overage:** Furnish 10% additional in number of each size and kind of globe (or a minimum of two, whichever is greater).
1. Generally use SF-2 insulated wire for rewiring existing or new wire at replicated light fixture. SF-1 may be substituted in those locations where space will not permit the installation of SF-2 and where the load is 6 amps or less. Provide 600 volt insulation.

2. Factory-wire all fixtures. Provide leads no shorter than 1'-0" or as required to suit the project application.

I. Connections:

1. Fasteners: Furnish fasteners of basic metal and alloy, matching finished color and texture as metal being fastened, unless otherwise indicated. For steel and aluminum fixtures, all screws, bolts, nuts, and other fastening and latching hardware shall be cadmium or equivalent plated. For stainless steel fixtures, all hardware shall be stainless steel. For bronze fixtures, all hardware shall be bronze.

2. Welding Materials: Type and alloy of filler metal and electrolydes as recommended by producer of metal to be welded, and as required for color match, strength and compatibility in the fabricated units.

J. Fixture Types:

1. LED Fixtures: Provide LED fixtures as scheduled on the Lighting Fixture Schedule, complete with LED light sources and drivers of the type, color, wattage and size scheduled.
   a. LED Light Source Packages: LED light source packages, arrays and modules used in luminaires shall be tested in accordance with LM-80 lumen depreciation tests and shall have a L70 rated minimum life of 50,000 hours.
   b. Temperatures around driver and in fixture housing shall not exceed 90°C with ambient room temperature at 27°C.

2. Pole-mounted Lighting Fixtures: Provide pole mounted lighting fixtures and poles of the types scheduled on the Lighting Fixture Schedule. Fixture manufacturers shall be as scheduled on the Lighting Fixture Schedule. Fixtures shall be furnished with all required accessories and trim as required for a complete installation.
   a. Fixtures shall be complete with the LED light sources of the type, color, wattage and size indicated on the Lighting Fixture Schedule, or as specified by the lighting fixture manufacturer. Unless otherwise noted, all HID lamps shall be clear.
   b. Fixtures shall be supplied with all fixture couplings and/or other accessories required by the manufacturer for proper installation to the pole.
   c. Poles shall be of the type scheduled and shall have base handholes and concealed mounting bolts, unless noted otherwise. Poles shall be installed plumb and true using leveling nuts above and below the pole base plate.
   d. Poles shall be painted to match luminaries, and shall be of the color indicated on the Lighting Fixture Schedule or as specified by the Architect.
   e. Separate in-line fuses shall be furnished and installed in each phase conductor at the pole base handhole, for each luminaire mounted on the pole. In-line fuse holders shall be Bussmann #HEB-AW-RYC, weatherproof, with insulated boots and breakaway feature, complete with Bussmann Type KTK fuses of the sizes required.
f. Concrete pole bases shall be sized with a minimum width or diameter equal to the diameter of the pole base anchor-bolt circle plus 6", which shall provide a minimum of 3" of concrete surrounding each of the anchor bolts. The concrete bases shall have reinforcing bars provided vertically and the anchor bolts shall be set with a template and tied or welded into the vertical reinforcing bars. The concrete bases and reinforcing bars shall be as detailed on the drawings and shall be provided and installed by the General Contractor. Pole base concrete shall have a minimum 28 day strength of 2500 psi.

g. The Electrical Contractor shall be responsible for installation of the concrete bases, and shall provide and install the lighting fixture(s), pole with handhole, anchor bolts, base cover, leveling nuts, grounding conductor, conduit and wiring, and in-line fuse(s).

K. Drivers:

1. LED Drivers: Non-dimming and dimming LED drivers shall operate LEDs within the current limit specifications of the LEDs being driven.

   a. All LED drivers shall have a Class A sound rating.

   b. LED drivers shall operate from a 60 Hz power source, have a power factor >90%, a minimum efficiency of 70% at the full rated load of the driver.

   c. LED drivers shall have integral short circuit and overload protection.

   d. LED drivers shall have a minimum starting temperature of 0 degrees F and a maximum case temperature of 70 degrees C.

   e. LED Driver output voltage shall be regulated to ±5% over the published driver load range.

   f. LED drivers shall comply with the requirements of Federal Communicartions Commission (FCC) rules and regulations, Title 47CFR part 15, non-consumer (Class A) for EMI/RFI.

   g. Dimming drivers shall be 0-10 VDC or phase shift as noted or scheduled on the drawings. Dimming drivers shall allow light output to be maintained at the lowest control setting, prior to off, without dropping out.

2. Voltage: Drivers for use on 120 volt systems shall be suitable and guaranteed for a voltage range of 100 to 130 volts. Drivers for use on 277 volt systems shall be suitable and guaranteed for a voltage range of 225 to 290 volts.

   a. Warranty: All LED drivers shall carry a unconditional warranty against defects in materials or workmanship, including replacement, for five years from date of manufacture including replacement for operation above the specified maximum case temperature. For LED sources and drivers, warranty shall include replacement for defects resulting in a fixture lumen depreciation >30%.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General:

1. Install lighting fixtures of the types indicated, where shown, and at the indicated heights in accordance with the fixture manufacturer's written instructions and recognized industry practices to ensure that the fixtures comply with the requirements and serve the intended purposes. Do not scale drawings for exact location of the lighting fixtures. In general, refer
to the architectural reflected ceiling plans for proper locations of lighting fixtures. Fixtures shall exactly fit the type of ceiling system scheduled for the space.

2. Fixtures shown on the fixture schedule to be recessed shall be complete with plaster frames, mounting yokes, rod hangers, etc., and/or any other accessories required to fit the fixture to the ceiling construction. However, where ceiling system cannot maintain said support, fixture supports shall be provided and rigidly attached to the structural members of the building capable of carrying the weight of the fixture plus 200 pounds at each support without sagging. Provide the necessary supports for hangers located between structural members.

3. All lighting fixtures shall be grounded and bonded to the case with a green wire color and green screw originated from the panelboard.

B. Standards: Comply with NEMA standards, applicable requirements of the NEC pertaining to installation of exterior lighting fixtures, and with applicable portions of the NECA’s "Standard of Installation".

C. Mounting: Fasten fixtures securely to the indicated structural support members of the building. Provide separate supports or mounting clips for all recessed ceiling-mounted lighting fixtures in accordance with the NEC. Check to ensure that solid pendant fixtures are plumb.

D. Appurtenances: Install each fixture properly and safely. Furnish and erect hangers, rods, mounting brackets, supports, frames, and other equipment required.

E. Coordination: Furnish lighting fixtures complete with appurtenances required for the proper, safe and distortion-free installation in the various surfaces in which they appear. Determine surface types from the Architectural drawings.

F. Instructions: Each lighting fixture shall be packaged with complete instructions and illustrations showing how to install. Install lighting fixtures in strict conformance with manufacturer’s recommendations and instructions.

G. Surface Mount Fixtures: Install surface mounted ceiling luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.

H. Wall Mounted and Pendant Fixtures: Install wall mounted and pendant lighting fixture plumb and at a height above the finished floor as specified in the drawings. In cases where conditions make this impractical, refer to the Architect for a decision. Use ball aligners and canopies on pendant fixtures unless noted otherwise.

I. Pendant Fixtures: Install pendant lighting fixture plumb and at a height above the finished floor as specified in the drawings. In cases where conditions make this impractical, refer to the Architect for a decision. Use ball aligners and canopies on pendant fixtures unless noted otherwise.

J. Suspended Fixtures:
   1. Fixture studs shall be provided in all outlet boxes from which fixtures are suspended. Fixtures shall not be suspended by means of cover or canopy screws. Canopies shall completely cover the ceiling opening of all ceiling fixtures except lay-in fixtures in T-bar construction, and trimless fixtures.
   2. Surface-mounted lighting fixtures (i.e. exit lights, etc.) are installed on lay-in panels in T-bar ceiling construction, the outlet boxes shall be rigidly supported to the ceiling system using
metal channels spanning perpendicular across the T-bars and securely attached to each side of the outlet box.

3. Chain-suspended lighting fixtures shall be connected to the outlet box mounted directly above the fixture using flexible metallic conduit strapped to the fixture chain. Suspension chain shall be heavy duty nickel or cadmium-plated.

K. Outlet Boxes: The locations indicated for outlet boxes of lighting fixtures are diagrammatic. Outlets shall be located as required to coincide with suspension hangers where they occur and with structural and architectural elements of the building and shall be located in accordance with the Architectural Reflected Ceiling Plan.

L. Fixture Designations: If a fixture-type designation is omitted, furnish fixture of the same type as shown for rooms of similar usage. Verify with Engineer before purchase and installation.

M. Installation Sequence: Do not install fixtures or such parts as finishing plates and trims for recessed fixtures until all plastering and painting that may mar fixture finishes has been completed. Install reflector cones, baffles, aperture plates, light controlling elements for air handling fixtures, and decorative elements after completion of ceiling tiles, painting and general cleanup.

N. Concealment: Whenever a fixture or its hanger canopy is applied to a surface mounted outlet box, a finishing ring shall be utilized as necessary to conceal the outlet box.

O. Garage Lighting Fixture Mounting: All typical lighting fixtures in garage shall be pendant-mounted with the bottom of the fixture 3” above the bottom of the structural joists.

P. Wire Guards/Tube Guards: Wire guards or tube guards shall be provided for all fixtures with exposed lamps where installed in mechanical/electrical spaces; in all locations below 8'-0” above finished floor; [and where lamps are exposed to damage.

Q. Concrete Pole Bases for Grade-mounted Installations: Branch circuit conduit for grade-mounted installations shall be routed underground into the concrete base and stubbed up with bushing into the center of the pole base. Conduit shall not be exposed on pole base. Provide 3/4” by 10’ copper ground rod with (1) one #8 ground wire secured to the ground lug on the pole. The length of the concrete bases below grade shall be as indicated on the Drawings or as recommended by the Architect/ Structural Engineer. Where the pole bases are installed in parking lots and along drives where exposed to vehicle traffic, the bases shall extend a minimum of 30” above finish grade. Where pole bases are installed in grass or landscape areas, (located away from the parking areas) the bases shall extend a minimum of 3” above finish grade. Refer to Section 26 05 01, "Electrical Basic Materials and Methods", for additional requirements.

R. Fusing: Refer to Section 26 28 13, "Low Voltage Fuses", for fusing for HID ballasts.

3.2 AIMING AND ADJUSTMENT:

A. All adjustable lighting units shall be aimed, focused, locked, etc., by the Contractor under the supervision of the Lighting Consultant. The Lighting Consultant shall indicate the number of crews (foreman and apprentice) required. All aiming and adjusting shall be carried out after the entire installation is complete.

B. All ladders, scaffolds, etc. required for aiming and adjustment shall be furnished by the Contractor at the direction of the Lighting Consultant. As aiming and adjustment is completed, locking setscrews and bolts and nuts shall be tightened securely.
C. Units shall be focused during the normal working day, where possible. However, where daylight interferes with precise focusing, aiming shall be accomplished at night.

3.3 CLEANUP:
A. At the time of final acceptance by the Owner, all lighting fixtures shall have been thoroughly cleaned with materials and methods recommended by the manufacturers, all broken parts shall have been replaced, and all lamps shall be operative. Replace blemished, damaged, or unsatisfactory fixtures as directed by Architect.

3.4 MAINTENANCE:
A. The Contractor shall be responsible for obtaining from his supplying lighting manufacturers, for each type of lighting fixture, a recommended maintenance information which shall be included in the Project Operating and Maintenance Manuals. Minimum information shall include:
   1. Tools required.
   2. Types of cleaners to be used.
   3. Replacement parts identification list.
   4. Final as-built shop drawings.

3.5 WARRANTY:
A. The Contractor shall warrant all fixtures, their finishes, and all of their component parts, except ballasts, to be free from defects for a period of one year from date of acceptance, if operated within rated voltage range. LED fixtures shall have a minimum 5 year warranty covering failure of all electrical components. Fixture installation shall be warranted for one year from the date of acceptance of the installation. During the warrantee period, repair or replacement of defective materials and/or repair of faulty workmanship or installation shall be provided at no cost to the Owner within 10 days of written notice of the defects as recorded and submitted by the Owner and/or Architect.

3.6 TESTING:
A. General: Upon completion of installation of lighting fixtures and after building circuitry has been energized, apply electrical energy to demonstrate proper operation of lighting fixtures and controls. When possible, correct malfunctioning units at the site, then retest to demonstrate proper operation; otherwise, remove and replace with new units and proceed with retesting.
B. Lamps: LED light sources may be utilized in the final finishing of the project.
C. Pre-inspection Tasks: Immediately before final inspection, thoroughly clean all fixtures inside and out, including plastics and glassware, adjust all trim to properly fit adjacent surfaces, replace broken or damaged parts and lamp, and test all fixtures for electrical and mechanical operation. Any fixtures or parts of fixtures, which have begun to show signs of rust or corrosion at the time of completion of the job, shall be removed and replaced with properly protected metal parts.

END OF SECTION 26 56 00

E&C Engineers & Consultants Inc.
TX Firm Registration No. F-003068
PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions and Supplementary General Conditions, Division 1 General Requirements, and 26 00 01 Electrical General Provisions, apply to this section.

1.2 SUMMARY:

A. The contractor shall Design, furnish and install a complete distributed microprocessor based 24VDC, electrically supervised, Silent Knight IFP-1000 fire alarm system as specified herein. The system shall include, but not be limited to, all control equipment, remote transponders, power supplies, signal initiating and signaling devices, conduit, wire, fittings, and all other accessories required to provide a complete and operable system.

B. The fire alarm system shall be designed and sealed by a licensed fire protection engineer registered in the state of Texas.

C. The system shall operate as a non-coded, continuous ringing system which will sound alarm devices until manually silenced, as herein specified.

D. The system shall be wired as a Class B and style 4 supervised system for all circuits.

E. System shall have a minimum of two loops and wired to allow expansion of each loop.

F. Contractor shall provide a backup copy of the installed program database on DVD, upon completion of the project. They shall also provide the current version of VeriFire-TCD for the panel provided.

G. Fire alarm control panel shall have a VOIP dialer with cellular backup.

H. The fire alarm system shall be monitored by a central monitoring company of the owners choosing.

1.3 STANDARDS

A. Products shall be designed, manufactured, tested, and installed in compliance with the latest edition of the following standards:

1. National Fire Protection Association Standards:
   a. NFPA 70 National Electrical Code.
   b. NFPA 72 Installation, Maintenance and Use of Protective Signaling Systems.
   c. NFPA 72E Automatic Fire Detectors.
   d. NFPA 72G Installation, Maintenance and Use of Notification Appliances for Protective Signaling Systems.
   f. NFPA 90A Installation of Air Conditioning and Ventilating Systems.
   h. NFPA 13 Sprinkler Systems.

2. Underwriters’ Laboratories, Inc. Requirements and Listing for use in Fire Protective Signaling Systems as follows:
   a. UL 864 Control Panels.
   b. UL 268 Smoke Detectors - Systems.
   c. UL 268A Duct Smoke Detectors.
d. UL 217  Smoke Detectors - Single/Multiple Station.
e. UL 521  Heat Detectors.
f. UL 228  Door Holders - Closers.
g. UL 464  Audible Signaling Appliances.
h. UL 1638  Visual Signaling Appliances.
i. UL 38  Manual Alarm Stations.
j. UL 346  Waterflow indicators for Fire Protective Signaling systems.
k. UL 1481  Power Supplies for Fire Protective Signaling systems.

3. Comply with requirements of the Texas Accessibility Standards.

1.4 QUALITY ASSURANCE:

A. Manufacturers: The basis of design for these specifications is a Silent Knight fire alarm system. All specific products listed below are basis of design only. Approved equivalent manufacturers are acceptable where they meet the requirements of these specifications.

1.5 CONTRACTOR QUALIFICATIONS:

A. The installing contractor shall be the authorized representative of the Fire Alarm Manufacturer to sell, install, and service the proposed manufacturer's equipment. The installing contractor shall have represented the fire alarm manufacturer's product for at least two years.

B. The installing contractor shall be licensed by the State Fire Marshall to sell, install and service fire alarm systems as required by Article 5.43-2 of the Texas Insurance Code.

C. The installing contractor shall have on his staff an installation technician licensed by the State Fire Marshall's office for such purpose and under whose supervision installation, final connections, and check out will take place as required by the Texas Insurance Code.

D. The installing contractor or equipment supplier shall have on staff a minimum of two (2) certified NICET Level III state licensed fire alarm planning superintendents under whose supervision system design shall take place. In lieu of an alarm planning superintendent, the contractor may provide design supervision by a State of Texas Registered Professional Engineer.

E. The installing contractor shall provide 24 hour, 365 days per year emergency service with factory trained, state licensed service technicians.

F. The installing contractor shall hold current certification to install and support Farenhyt fire alarm systems by Silent Knight or the equivalent manufacturer that is selected.

G. The installing contractor shall have been actively engaged in the business of selling, installing, and servicing fire alarm systems in the surrounding area for at least ten (10) years.

H. Where approved in writing by the system manufacturer and installing contractor, the Electrical Contractor may install all conduit and boxes, provided that all device rough-ins are installed in full compliance with the spacing and mounting height requirements of NFPA 72. The system wiring shall be planned, pulled, routed, secured, installed, and terminated by the fire alarm contractor. Device back-boxes, raceway, 120VAC power connections & circuits, penetrations, fire stopping, and other typical electrical construction provisions shall be provided by others. Installation and support of typical electrical construction provisions shall be provided by others in a manner consistent with all applicable codes, standards, owner's requirements (as specified) and manufacturers' installation documentation. All system connections, device installation, system start-up and testing shall be performed by the installing contractor. Rough-in by the electrical contractor shall not in any way affect the system manufacturer's and installing contractor's full responsibility for the installed fire alarm system.

I. The system as installed shall, upon completion, be certified by a State Licensed Fire Alarm Installation Superintendent to the Owner as being installed in compliance with the specification, the requirements of all state and local codes, and as being operational and free from defects.
J. All system equipment supplied shall be listed by the Underwriters' Laboratories for NFPA 72 system use, and all applicable NFPA Codes.

1.6 SUBMITTALS:

A. All submittals shall be sealed by a licensed fire protection engineer registered by the state of Texas. Shop Drawings submittals shall include manufacturer's name, model numbers, ratings, power requirements, equipment layout, conduit, device arrangement, and complete point to point wiring diagrams along with other required information including, but not be limited to, the following:

1. A written description of the system operation (written in this specification format), with all exception and/or deviations clearly highlighted or identified.

2. General drawing notes.

3. Control equipment schedules.

4. Detailed input/output matrix showing alarm and control function for an alarm in each device/zone.

5. Detailed legend.

6. A control panel layout diagram and schedules showing the location of all modules and wiring and interconnection schematics.

7. Panel Schematics showing all connections, between modules within panels, to all modules from field wiring with zones identified.

8. Riser Diagrams indicating circuits, type of devices, number of devices, number of conductors, conduit size, junction boxes and zones.

9. Scaled floor plan drawings locating and naming each device/zone and showing wiring and conduit sizes from each device back to the fire alarm control panel and including:
   a. Device point numbers
   b. Wattage setting and dB for each audible signaling device labeled adjacent to the device.
   c. Candela rating for each strobe labeled adjacent to the strobe.

10. A complete riser/wiring diagram showing zoning and addressing and wiring and conduit sizes from the control panel to all remote terminal cabinets and system devices.

11. Electrical back box requirements.

12. Product Data: Provide electrical characteristics, connection requirements and compatibility listing showing that components are compatible with each other including but not limited to:
    a. Full equipment list including model numbers and quantities
    b. Complete system operation
    c. Highlighted Data Sheets on Devices and Products
    d. Fire Alarm Control Panel
    e. Batteries
    f. Detectors
    g. Manual Stations
    h. Audible Signaling Devices
    i. Visual Signaling Devices
    j. Control Devices
    k. Wiring diagrams of all equipment
    l. Installation instructions for all equipment
    m. Equipment testing procedures
    n. Equipment maintenance manuals
    o. Wiring
p. Wire data sheets.

13. System Calculations - Complete calculations shall be provided which show the electrical load on the following system components (identify all mathematical formulas, variables, and constants used in all calculations):
   a. Each system power supply, including stand-alone booster supplies.
   b. Standby battery calculations plus a 20 percent de-rating factor.
   c. Voltage drop calculations for each type of circuit.
   d. Calculated sound level required at each speaker to meet specified audibility requirements.
   e. dB loss calculations for speaker circuits.
   f. Audible signaling device circuit loading.
   g. Strobe circuit loading.
   h. Each auxiliary control circuit that draws power from any system power supply.
   i. 120VAC power requirement calculations.

1. Complete Bill of Material for all equipment.
2. Software and Database Information:
   a. A complete listing of all associated software showing the relationship of alarm points, control outputs, control inputs and indicators.
   b. A printout showing the proposed point numbers. Device designations, zone assignments and English language messages for each device/zone and for each control function, as applicable.
   c. Add Programming rules and Equations, with comments listed.
3. A copy of the form to be used for final tests, 100% audit and checkout shall be submitted for approval.
4. The submittal package shall be signed by the State of Texas Fire Alarm Planning Superintendent (NICET III) or signed and sealed by a Professional Engineer (PE) registered in Fire Protection in the State of Texas. All code deficiencies and/or variances shall be noted on the fire alarm submittals and/or drawings.
5. Additional information as required in Section 26 00 01, “Electrical General Provisions”.

1.7 DELIVERY, STORAGE AND HANDLING:
   A. Deliver fire alarm system components in factory-fabricated containers.
   B. Store in a clean, dry space and protect from the weather.
   C. Handle control and annunciator panels carefully to avoid damage to material components, enclosure and finish.

PART 2 - PRODUCTS

2.1 SYSTEM GENERAL REQUIREMENTS:
   A. The required fire alarm and evacuation system providing a system with the following functions and operation:
      1. Locate main fire alarm panel as shown on fire alarm drawings
      2. Provide a lightning protection kit.
      3. Performance Requirements:
         a. The automatic battery charger shall be capable of charging a fully discharged battery to 70% capacity in 12 hours.
         b. The fire alarm control panel shall be Silent Knight IFP-1000. All subpanels shall be analog addressable (i.e. Power Booster) Silent Knight Model #5895XL.
4. All control panel and power booster batteries shall be 12 Volt, 18 AmpHr or higher, no exceptions shall obtain its primary operating power from a 120 BAC single phase 60 Hz supply provided with a dedicated and secured disconnect switch.

5. The fire alarm and evacuation system shall comply with NFPA 72 and all applicable local codes.

6. All Control panel batteries shall be 12 Volt, 18 AmpHr or greater. Installation dates shall be clearly marked on batteries.

7. All wiring shall be non-power, unlimited power supply or plenum rated.

8. Panel programming shall include device descriptions and zoning per floor per building (i.e. zone 1= main building first floor Administrative Suite, zone 2= main building first floor corridor east, zone 3=main building learning centers). Panel programming shall be supplied to owner via a hardcopy and electronic.

2.2 MATERIALS AND COMPONENTS:

A. General: Provide the required fire alarm system products in the sizes and capacities required or indicated, complying with the manufacturer's published product information of standard materials and components, designed and constructed for the applications indicated.

B. All fire alarm control units shall be intelligent, addressable Central Processing Units (CPU) based and meets the latest edition of UL 864. All Fire Alarm System components shall be keyed alike.

C. All FACPUs shall be capable of providing circuit integrity monitoring for all Signaling Line Circuits at a level of Class A, as defined in NFPA 72.

D. All FACPUs shall be capable of providing circuit integrity monitoring of Initiating Device Circuits (IDC's) at a level of Class B as defined in NFPA 72.

E. All FACPUs shall be capable of providing circuit integrity monitoring of Notification Appliance Circuits (NAC's) at a level of Class B as defined in NFPA 72.

F. Panels shall have provisions for smoke detector "Alarm Verification" for Signaling Line Circuits shall be provided.

G. Manufactured terminal boxes shall be labeled “FIRE ALARM TERMINAL BOX” and shall be Space Age TC2 series or equal.

H. With each installed field device affix a label to indicate the devices full address on its signaling line circuit.

I. Legibly mark each cable or wire to designated terminal with labeling tool.

J. All FACPUs shall provide twenty percent (20%) excess power supply, input circuit, and output circuit capacity at final acceptance to allow for future expansion by the Owner.

K. Zone labeling shall be textual by alpha-numeric display at the FACPU and remote annunciator to allow “first response” by persons not trained in fire alarm technology.

L. Textual (alpha-numeric) language shall be conventional, concise, clear and accurate to facilitate rapid response. The label shall contain the device type, floor location, equipment or area served, and an exact device location,

M. All FACPUs shall provide a control to bypass the Public Alarm to allow for maintenance and testing, and to reduce disruption.

N. All FACPUs shall provide controls to override door holder release, smoke control activation, damper activation, and fan shutdown features to allow for maintenance and testing. Program panel to allow functions to be disabled by floor or by group as required by Owner. A means to disable all water flow devices shall be provided.

O. All FACPUs shall be connected to a Primary and Secondary Power source. The secondary power supply shall be sized to provide 5 minutes of operation in alarm conditions after 24 hours of system operation in standby power.
P. All FACUs shall provide a separate digital address for each initiating device to facilitate rapid response and maintenance and testing.

Q. All FACPUs shall provide a separate digital address for each individual flow switch.

R. All programming shall be permanent and non-volatile to reduce outage time due to failure.

S. All FACUs shall be listed and approved as the smoke detector sensitivity test set to reduce maintenance costs.

T. All FACPUs shall be capable of providing drift compensation. Drift compensation is considered equal to adjustability at the detector.

U. All FACPUs shall be field programmable, using internal or connected components, for all changes, alterations, modifications, additions, deletions and hardware and software upgrades.

2.3 SYSTEM OPERATION:

A. Area Smoke Detectors: Activation of an "intelligent" smoke detector shall cause the following operations and indications (refer to other paragraphs in this section for additional operations and indications):

1. When an alarm condition is detected by an automatic smoke detector programmed for ALARM VERIFICATION using a UL listed alarm verification feature, an alarm verification sequence shall be initiated. Upon receipt of the initial alarm condition, the FACP shall start the verification sequence as prescribed by UL 864. The system shall rest the alarmed zone/device within the UL prescribed window of 60 seconds maximum. If the alarm condition does not confirm within 60 seconds of the reset signal, the programmed alarm outputs shall be canceled and the system returned to the normal mode. If the alarm condition re-occurs within the designated verification cycle or a non-verified device or zone activates, the programmed events listed above shall immediately occur for the confirmed alarm condition.

2. Alarm verification shall be per addressable, open area smoke detector shall be field programmable by detector on an individual detector basis. The system shall incorporate the ability to log in memory the number of verification events that have occurred for each selected device. Alarm verification which is Global or Dyde alarm verification is not acceptable.

3. Alarm verification shall not be used for any spaces programmed to required two smoke detectors to initiate an alarm response (ex. elevator lobbies).

4. The system common alarm LED on the Fire Alarm Control Panel shall flash. The internal audible trouble device shall sound. Acknowledging the alarm condition shall silence the audible trouble device and revert the flashing common alarm LED to a steady state.

5. An alpha-numeric LCD Display shall indicate all applicable information associated with the alarm condition including: zone, device type, device location and time of alarm. Location and zoning messages shall be custom field-programmed to respective premises.

6. Activate and automatic telephone dialer and alarm contact closure for use with approved central station monitoring service. Owner shall provide the NFPA 71 central station connection and maintain this service.

7. Appropriate status change message(s) shall be transmitted to all annunciators, graphics terminals, CRT displays and printers and an alarm shall be transmitted to a remote Central Station.

8. Activate a distinctive evacuation signal at all audible alarm devices on the floor of alarm, the floor above and the floor below.

9. Activate and flash all visual alarm signal zones on the floor of alarm, the floor above and the floor below.

10. Activate addressable output relays to shut down all mechanical equipment rated 2000 cfm or greater that circulate air for the floor of alarm. This equipment shall include, but shall not be limited to, air handling units, ventilation fans, fan powered boxes, and side pocket boxes.
11. Activate addressable output relays to close all fire/smoke dampers serving the floor of alarm.

12. Activate addressable output relays to release all fire and smoke control doors on hold-open devices so that doors may close.

13. Activate addressable output relays to unlock all locked security doors.

14. All alarm signals shall continue sounding and annunciator(s) shall remain lighted until the alarm acknowledged switch is depressed. The alarm signals shall then stop, but the annunciator shall remain lighted until the system is rest.

15. Acknowledging of any alarm signal shall interfere with the re-activating of the alarm signals upon an alarm from another zone.

B. Manual Pull Stations: Activation of any addressable manual pull station shall cause the following operations and indications (refer to other paragraphs in this section for additional operations and indications):

1. Cause all operations and indications described in Paragraph 2.3/A.3 through 2.3/A.16 to occur.

C. Air Sampling Smoke Detector Systems: Activation of any air sampling smoke detector system shall cause the following operations and indications (refer to other paragraphs in this section for additional operations and indications):

1. Cause all operations and indications described in Paragraph 2.3/A.3 through 2.3/A.16 to occur.

D. Sprinkler Waterflow Switches: Activation of any addressable sprinkler waterflow switch shall cause the following operations and indications (refer to other paragraphs in this section for additional operations and indications):

1. Cause all operations and indications described in Paragraph 2.3/A.3 through 2.3/A.16 to occur.

2. Activate the sprinkler alarm bell, if provided.

E. Heat Detectors: Activation of any heat detector shall cause the following operations and indications (refer to other paragraphs in this section for additional operations and indications):

1. Cause all operations and indications described in Paragraph 2.3/A.3 through 2.3/A.16 to occur.

F. Air Handling Unit (AHU) Duct Smoke Detectors: Duct-mounted smoke detectors for AHU shutdown shall be located in the AHU supply and return ductwork as shown on the drawings and required by NFPA 90A. Activation of a AHU duct detector shall cause the following operations and indications:

1. Indicate AHU-### Shutdown on the FACP and remote annunciator alpha-numeric displays.

2. Cause all operations and indications described in Paragraph 2.3/A.3 through 2.3/A.16 to occur.

3. Initiate via an addressable output relay which is external from the duct detector and located within three feet of the AHU motor starter/VSD, opening the control circuit for the AHU associated with the duct detector. The addressable relay shall have form "C" relay contacts shall be rated for the load and interrupt power to the AHU control circuit without additional interposing relays.

G. Fire/Smoke Damper Duct Smoke Detectors: Duct-mounted smoke detectors for damper control shall be located within 5 feet of the controlled damper. Activation of a fire/smoke damper duct detector shall cause the following operations and indications:

1. Cause all operations and indications described in Paragraph 2.3/A.3 through 2.3/A.16 to occur.

2. Initiate via an addressable output relay which is external from the duct detector and located within three feet of the fire/smoke damper or power supply for motor drives or fail-safe dampers, removing power for the fire/smoke damper associated with the duct detector. The
addressable relay shall have form “C” relay contacts shall be rated for the load and interrupt power to the fire/smoke damper without additional interposing relays. When fail-safe smoke dampers are powered in parallel from a common power circuit then fire alarm relay may be provided to interrupt common power circuit; separate relay not necessary at every such damper. Resetting fire alarm system shall include opening fire/smoke dampers.

H. **Valve Supervision:** Closure of a supervised OS&Y or PIV valve sensed via a supervisory switch or loss of supervisory air pressure in a dry-pipe sprinkler system, sensed via a pressure switch shall cause the following operations and indications:

1. The system common alarm LED on the Fire Alarm Control Panel shall flash. The internal audible trouble device shall sound. Acknowledging the alarm condition shall silence the audible trouble device and revert the flashing common alarm LED to a steady state.

2. An alpha-numeric LCD Display shall indicate all applicable information associated with the alarm condition including: zone, device type, device location, and time of alarm. Location and zoning messages shall be custom field-programmed to respective premises.

3. Appropriate status change message(s) shall be transmitted to all graphics terminals, CRT displays, and printers.

I. **Supervision:** The presence of a ground condition or an open circuit on any alarm initiation circuit or a ground condition, open circuit or short circuit on any alarm indicating circuit, blockage, lens contamination or physical misalignment of any beam type smoke detector, a trouble condition at a fire suppression system panel or other trouble condition shall cause the following actions and indications:

1. The system common trouble LED on the Fire Alarm Control Panel shall flash. The internal audible trouble device shall sound. Acknowledging the alarm condition shall silence the audible trouble device and revert the flashing common trouble LED to a steady state.

2. An alpha-numeric LCD Display shall indicate all applicable information associated with the trouble condition and its location. System trouble diagnostics shall assist in defining the trouble condition. Unacknowledged alarms/messages shall have priority over any trouble displays and take precedence on the LCD annunciator. Trouble conditions will be stored in memory for future recall/display.

3. Appropriate status change message(s) shall be transmitted to all annunciators, graphics terminals, CRT displays and printers.

J. **Auxiliary Control Functions:** All designated "non-silenceable" auxiliary control functions shall remain in operation (even upon silencing of audible alarms) until such time as the control panel is cleared and reset manually (i.e. fan control outputs, central station interface, elevator recall interface, etc.).

K. **Manual Controls:** Provisions shall be included within the Fire Alarm Control Panel for the following manual controls in addition to those previously mentioned:

1. Disconnect audible signaling while testing.

2. Temporary software bypass of selected alarm points.

3. Software assignment of selected alarm points to alarm verification function as a method of tracking alarms caused by environmental factors or maintenance requirements. Waterflow switches, smoke detectors, and valve supervisory switches shall be assigned to the verification group to eliminate nuisance alarms.

2.4 **SYSTEM DEVICES:**

A. System devices shall be located as shown on the Drawings. All system devices shall be provided as shown on the Drawings shall be provided. Additional devices and components shall be provided as required and in locations required to provide a fully functional fire alarm system which is in compliance with all applicable codes and standards.
B. The Contractor shall refer to all the drawings to determine where devices are to be located. All system devices shall be numbered with a unique address and serial number. The device identification system shall include the proposed device location message, type of device, panel number, SLC number, logical system address and 10-digit device serial number. This numbering system shall be shown on each submitted floor plan drawing, fire alarm riser diagram and be tabulated. The tabulation shall be included in each O&M Manual submitted to the Owner. Only device serial numbers may be excluded from submittal package but must be included in as-built documentation as part of the O&M Manual submitted to the Owner. All field devices shall have their respective 10-digit serial number conspicuously displayed on each respective device for inspection tracking purposes by the Owner. Device Addresses shall be as follows:

1. One address for each automatic and manual alarm initiating device.
2. Each waterflow initiating device shall be a distinct separate address and shall identify a sprinkler activated alarm condition by switch.
3. Each PIV; and riser sprinkler flow and supervisory switches shall be monitored on separate addresses from addressable input modules.
4. A distinct sprinkler supervisory circuit shall supervise and monitor the associated sprinkler system control valves and initiate a supervisory alarm condition should operation of the valves make the sprinkler system inoperative. Supervisory conditions on this circuit shall be differentiated from fault conditions on associated circuit wiring.

2.5 SYSTEM ZONING:

A. The system shall employ "intelligent" manual pull stations, heat and smoke detectors and addressable interface devices capable of being recognized and annunciated at the main control panel and CRT terminals on an individual basis. All devices shall be field-programmed into software zones for the purpose of general area identification and annunciation. However, each device shall also be annunciate identified on an individual basis including exact location and device type. All zoning/device location information shall be totally field-programmable to exact job requirements. Devices shall be zoned as follows:

1. Manual pull stations, area smoke and heat detectors and sprinkler water flow and pressure switches shall be zoned by floor.
2. A separate zone grouping shall be provided for air sampling smoke detector system and area smoke and heat detectors and sprinkler water flow and pressure switches which serve the atrium area for purposes of activating the atrium smoke evacuation system.
3. Elevator lobby, machine room and shaft smoke detectors shall be zoned by elevator group.
4. HVAC equipment supply air and return air duct smoke detectors and fire/smoke damper duct smoke detectors shall be zoned by floor and smoke compartment.
5. Fire suppression systems, kitchen hood fire suppression system, fire pump monitoring and similar functions shall each be zoned separately.

B. The system shall utilize remote transponder panels for initializing circuits and auxiliary control output circuits. Remote transponder panels shall communicate with the main CPU via the SLC data loop and be capable of being intermixed on the same loop as intelligent heat and smoke detection and control modules.

C. All FACPUs shall provide circuit integrity monitoring for all Signaling Line Circuits at a level of Class A, Style 6, serving no more than 3 levels with short isolators in place for each level. All the following devices/appliances shall be individually addressed on the SLC:

2. Ceiling (spot-type) smoke detectors.
3. Duct smoke detectors.
5. Sprinkler waterflow, shutoff, and pressure switches.
7. Control devices.
8. Initiating Device Circuits (IDCs).
11. Fire pump controller

D. Initiating and monitored devices shall include, but not be limited to, the following:
   2. Ceiling smoke detectors.
   3. Duct smoke detectors.
   4. Ceiling heat detectors.
   5. Addressable input devices.
   7. Valve supervisory switches.
   8. Damper and fire shutter supervisory switches.
  10. Fire pump controllers.

E. All Notification Appliance Circuits (NACs) shall be monitored at a level of Class B with direct current notification appliance power provided from a distributed power supply shall be controlled by a digital addressable control device on the SLC. Output devices shall include, but not be limited to, the following:
   1. Wall/ceiling audible devices, strobe and audible device/strobe alarm indicating devices.
   2. Wall/ceiling addressable and conventional outputs including remote power supplies.
   3. Interface relays and other auxiliary devices & systems.
   4. TELCO and Ethernet communicators.

F. Output devices shall include, but not be limited to, the following:
   1. Wall and ceiling alarm audible devices.
   2. Wall and ceiling alarm audible devices/visual signals.
   4. Addressable interface relays.
   5. Magnetic door holders.

2.6 SYSTEM CONFIGURATION:

A. System equipment shall include, but not be limited to an operator's control/system control panel, remote transponder panels, firefighter's HVAC override, battery backup, alarm indicating devices, door hold opens and output relays and other devices required to provide a complete and working system.

B. The system control unit shall be connected to remote transponder panels on a looped signaling line circuit. The wiring of the loop shall be so arranged that additional transponder panels may be inserted in the loop without requiring additional wires to be installed between transponder panel and the system control unit. In additional, loops shall be so arranged that any wiring fault on a loop shall not disable more than 250 initiating devices. A single open ground or multiple opens in different wires at the same location shall not prevent receipt of alarm signals from that loop.

C. The system shall be of the active multiplex/addressable type wherein each initiating device shall be repetitively scanned, causing a signal to be transmitted to the control unit that indicates the individual initiating device circuit installation wires are intact. Loss of such a signal at the system
control unit shall result in a trouble indication as specified hereinafter for the particular indicating device affected. All indicating devices in the system shall transmit their normal, trouble or actuated status signals in no less than 5 second intervals.

D. Each individual smoke detector shall be of the analog type so that the system can be used to read smoke levels on a real time basis from selected smoke detectors for maintenance and diagnostic purposes. All smoke detectors and other initiating devices shall be individually indicated at the main control panel, the color graphics unit and each DGP, when changing to an alarm or trouble state.

2.7 CONTROL PANEL:

A. The fire alarm control panel (FACP) shall be the Silent Knight IFP-1000 analog addressable control panel. The FACP must have a 6 amp power supply and be capable of expansion to a maximum of 54 total amps via bus connected expander modules that supervise low battery, loss off AC and loss of communication.

B. The FACP must have Day/Night sensitivity capabilities on detectors and be capable of supporting 127 analog addressable points and expandable to a maximum of 1016 analog addressable points. This shall be accomplished via eight signaling line circuits (SLC) capable of supporting a minimum of 127 devices each. The communication protocol on the SLC loop must be digital.

C. The FACP must support a minimum of six programmable Flexput® circuits. The panel must have a built in 80 character LCD annunciator with the capability of having an additional eight supervised remote annunciators connected in the field.

D. The FACP must have a built in UL approved digital communicator. The communicator must allow local and remote up/downloading of system operating options, event history, and detector sensitivity data.

E. The FACP must automatically test the smoke detectors in compliance with NFPA standards to ensure that they are within listed sensitivity parameters and be listed with Underwriters Laboratories for this purpose.

F. The FACP must compensate for the accumulation of contaminants that affect detector sensitivity.

G. The FACP must have day/night sensitivity adjustments, maintenance alert feature (differentiated from trouble condition), detector sensitivity selection, auto-programming mode (Jumpstart) and the ability to upgrade the core operating software on site or over the telephone.

H. The FACP shall have a Jumpstart feature that can automatically enroll all properly connected accessories into a functional system within 60 seconds of powering up the panel. Panels that do not have these capabilities will not be accepted.

I. The main communication bus (S-Bus RS485) shall be capable of class A or class B configuration with a total Bus length of 6,000 feet.

J. The fire alarm control panel shall have an NFPA required document box.

K. The system shall provide the following communications cards/modules:
   1. RS-232 Communication Card with (2) optically isolated RS-232 ports for CRT, modem, and/or printer.
   2. RS-485A Network Communications Card for supervised remote annunciators.

2.8 SYSTEM WIRING:

A. The SLC and Data Communication Bus shall be wired with standard NEC 760 compliant wiring, no twisted, shielded or mid capacitance wiring is required for standard installations. All FACP screw terminals shall be capable of accepting 14-18 AWG wire. All wire shall be red jacketed cable approved by UL and NEC760 for fire system use.

2.9 SIGNALING LINE CIRCUITS:
A. Each SLC shall be capable of a wiring distance of 10,000 feet from the SLC driver module and be capable of supporting 127 devices. The communication protocol to SLC devices must be digital. Any SLC loop device, which goes into alarm, must interrupt the polling cycle for priority response from the FACP. The FACP must respond consistently to a device that goes into alarm on an SLC in under 3 seconds. The auxiliary 5815XL SLC loop module must be capable of being located up to 6000 feet from the FACP on an RS-485 bus, which is separate from the SLC bus. The SLC shall be capable of functioning in a class A or class B configuration.

2.10 SLC LOOP DEVICES:
A. Devices supported must include analog photoelectric, ionization smoke detectors, analog heat detectors, addressable input modules, relay output modules or addressable notification modules. There is to be no limit to the number of any particular device type up to the maximum of 127, that can be connected to the SLC.

2.11 ANALOG DETECTOR FUNCTIONS:
A. The products of combustion detectors must communicate analog values using a digital protocol to the control panel for the following functions:
   1. Automatic compliance with NFPA 72 standards for detector sensitivity testing.
   2. Drift compensation to assure detector is operating correctly.
   3. Maintenance alert when a detector nears the trouble condition.
   4. Trouble alert when a detector is out of tolerance.
   5. Alert control panel of analog values that indicate fire.

2.12 SENSITIVITY FUNCTION:
A. The FACP shall have the ability to set three different sensitivity levels. A zone can be programmed to a day and a night sensitivity value. The day/night schedule shall allow for 16 holiday dates that are user programmable to allow the FACP to respond at the night level on those days.

2.13 PROGRAMMABLE FLEXPUTS:
A. The FACP shall support six programmable Flexput® circuits that are capable of being programmed as supervised reverse polarity notification circuits or supervised auxiliary power circuits that can be programmed as continuous, resettable or door holder power. The circuits shall also be programmable as input circuits in class A or B configurations to support dry contact or compatible two wire smoke detectors.

2.14 ADDRESSABLE NOTIFICATION MODULE:
A. The FACP shall support Addressable Notification Modules that supply reversing 24 VDC current to notification power supply's or voice evacuation systems. The ANM shall reside on the SLC loop and be placed anywhere on the 10,000ft. loop.

2.15 ANNUNCIATORS:
A. The main control must have a built in annunciator with an 80 character LCD display and feature LED's for General Alarm, Supervisory, System Trouble, System Silence and Power. When in the normal condition the LCD shall display time and date based on a 200 year clock which is capable of automatic daylight savings time adjustments. All controls and programming keys are silicone mechanical type with tactile and audible feedback. Keys have a travel of .040 in. No membrane style buttons will be permissible. The annunciator must be able to silence and reset alarms through the use of a keypad entered code, or by using a firefighters key. The annunciators must have two levels of user codes that will allow the limitation of operating system programming to authorized individuals.

2.16 REMOTE ANNUNCIATORS:
A. The fire system shall be capable of supporting up to eight remote LCD annunciators in any combination. LCD remote annunciator Model RA-1000 shall have the same control and display layout so that they match identically the built in annunciator. The RA-1000 shall have the same functionality and operation as the built in annunciator. LCD remote annunciator Model RA-1000 shall be an approved optional annunciator. All annunciators must have 80-character LCD displays and must feature five LED's for general alarm, supervisory, system trouble, system silence, and system power. All controls and programming keys are silicone mechanical type with tactical and audible feedback. Keys shall have a travel of .040 inches. No membrane style buttons will be permitted.

B. The RA-1000 must be able to acknowledge, silence and reset alarms without the use of a code. The RA-1000 must silence and reset alarms with the user of a code or firefighter's key. The annunciators must have 20 programmable user codes that will limit the operating system programming to authorized individuals. The control panel must allow all annunciators to accommodate multiple users input simultaneously. Remote annunciators shall be capable of operating at a distance of 6000 feet from the main control panel on unshielded non-twisted cable.

2.17 I/O MODULES

A. The fire system shall be able to support up to eight Model 5880 I/O modules that shall be used to drive remote LED graphic style displays and accommodate up to eight dry contact type switch inputs. The I/O modules shall each drive up to 40 LEDs without requiring external power connections. The I/O module inputs shall be supervised and be suitable for alarm and trouble circuits as well as reset and silence switches.

2.18 SERIAL/PARALLEL INTERFACE:

A. The fire system shall be capable of supporting up to two Model 5824 serial / parallel interfaces that are capable of driving standard computer style printers. The interface shall be programmable as to what information is sent to it and shall include the ability to print out Detector Status by point, Event History by point and System Programming.

2.19 DISTRIBUTED POWER MODULE:

A. The contractor shall supply (where required) a power module model RA-1000 compatible with the IFP-1000 fire alarm control panel. The power module must have 6 amps of output power, six notification circuits rated at 3 amps each, and two form C relay circuits rated at 2.5 amps at 24 volts DC. The six notification circuits shall have the same functionality as the notification circuits on the main panel. The RPS-1000 shall be capable of being connected via a RS-485 system bus (SBUS) at a maximum distance of 6000 feet from the main control panel. The power module shall contain an additional RS-485 bus that is completely compatible with all IFP-1000 add on modules including RA-1000 Remote Annunciators, 5824 serial/parallel modules and addressable devices. The power module will also act as a bus repeater so that additional RS-485 (modules) devices can be connected at a maximum distance of 6000ft. from the power module.

B. The contractor shall supply (where required) a power module model 5496 compatible with the IFP-1000 fire alarm control panel. The power module must have 6 amps of output power with four notification circuits rated at 3 amps each. The four notification circuits shall have the same functionality as the notification circuits on the main panel. The 5496 shall be capable of being connected via a RS-485 system bus (SBUS) at a maximum distance of 6000 feet from the main control panel.

C. The IFP-1000 shall be capable of supporting up to eight (8) of the Distributed Power Modules in any combination.

D. The power module's RS-485 bus shall be electrically isolated providing ground loop isolation and transient protection.

2.20 DIGITAL COMMUNICATOR:
A. The digital communicator must be an integral part of the control panel and be capable of reporting all zones of alarm, supervisory, and trouble as well as all system status information such as loss of AC, low battery, ground fault, loss of supervision to any remote devices with individual and distinct messages to a central station or remote station. The communicator must also be capable of up/downloading of all system programming options, Event history and Sensitivity compliance information to a PC on site or at a remote location. The communicator shall have an answering machine bypass feature that will allow the panel to respond to communication even on phone lines that have other communication equipment present. The communicator must be capable of reporting via SIA and Contact ID formats. The communicator shall have a delayed AC loss report function which will provide a programmable report delay plus a 10-25 min random component to help ease traffic to the central station during a power outage. No controls that use External modems for remote programming and diagnostics shall be accepted.

2.21 DRY CONTACTS:
A. The FACP will have three form "C" dry contacts, one will be dedicated to trouble conditions, the other two will be programmable for alarm, trouble, notification, pre-alarm, waterflow, manual pull, aux. 1 or aux. 2. The trouble contact shall be normal in an electrically energized state so that any total power loss (AC and Backup) will cause a trouble condition. In the event that the Microprocessor on the FACP fails the trouble contacts shall also indicate a trouble condition.

2.22 GROUND FAULT DETECTION:
A. A ground fault detection circuit, to detect positive and negative grounds on all field wiring. The ground fault detector shall operate the general trouble devices as specified but shall not cause an alarm to be sounded. Ground fault will not interfere with the normal operation, such as alarm, or other trouble conditions.

2.23 OVERCURRENT DETECTION:
A. All low voltage circuits will be protected by microprocessor controlled circuit breakers or have a self restoring circuit breaker for the following: smoke detector power, main power supply, indicating appliance circuits, battery standby power and auxiliary output.

2.24 TEST FUNCTIONS:
A. A "Lamp Test" mode shall be a standard feature of the fire alarm control panel and shall test all LED's and the LCD display on the main panel and remote annunciators.
B. A "Walk Test" mode shall be a standard feature of the fire alarm control panel.
C. The walk test feature shall function so that each alarm input tested will operate the associated notification appliance for two seconds. The FACP will then automatically perform a reset and confirm normal device operation. The event memory shall contain the information on the point tested, the zone tripped, the zone restore and the individual points return to normal.
D. A "Fire Drill" mode shall allow the manual testing of the fire alarm system notification circuits. The "Fire Drill" shall be capable of being controlled at the main annunciator, remote annunciators and via a remote contact input.
E. A "Bypass Mode" shall allow for any zone, point, group, or NAC circuit to be bypassed without effecting the operation of the total fire system.

2.25 REMOTE INPUT CAPABILITIES:
A. The control panel shall have provisions for supervised switch inputs for the purpose of Alarm reset and Alarm and trouble silence.

2.26 NOTIFICATION APPLIANCE MAPPING STRUCTURE:
A. All notification circuits and modules shall be programmable via a mapping structure that allows for a maximum of 250 output groups. Each of these groups shall have the ability to be triggered by any of the panels 125 Zones. A zone may trigger from groups individually, or may contain a global
trigger for manual pull stations, fire drills and two different system alarms. Additionally each zone will individually control the cadence pattern of each of the groups that it is "Mapped" to so that sounders can indicate a variety of conditions. The zone shall be capable of issuing a different cadence pattern for each of the groups under it's control. The mapping structure must also allow a group to be designated to "ignore cadence" for use with strobes and other continuous input devices. zones shall have eight different output categories: Detector alarm, Trouble, Supervisory, Pre-alarm, Waterflow, Manual Pull, Zone Auxiliary one and Zone Auxiliary two. Each of the categories shall have the ability to control from 1 to 8 output groups with a cadence pattern. The patterns are: March code, ANSI 3.41, Single Stroke Bell Temporal, California code, Zone 1 coded, Zone 2 coded, Zone 3 coded, Zone 4 coded, Zone 5 coded, Zone 6 coded, Zone 7 coded, Zone 8 coded, Custom output pattern 1, Custom output pattern 2, Custom output pattern 3, Custom output pattern 4, and Constant. This mapping/cadence pattern shall be supported by all system power supplies and Notification Expander Modules.

2.27 ON BOARD PROGRAMMER:
A. The FACP shall have an on board programmer which will allow for all system functions and options to be programmed via the on board annunciator keypad. Any panel that does not have this capability will not be accepted.

2.28 DOWNLOADING SOFTWARE:
A. The fire alarm control panel must support up/downloading of system programming from a PC under Windows 98, Windows XP, or Windows Vista. The FACP must also be able to download the detector sensitivity test results and a 1000 event system event buffer to the PC. Communication shall take place over a direct connection to the PC and/or via the same telephone lines as the built in digital communicator and shall not require an external modem to be connected to the panel. The downloading software shall contain a code that will block unauthorized persons from accessing the panel via direct connection or over the phone lines.

2.29 FACILITY MANAGEMENT SOFTWARE:
A. The FACP must support facility management software capable of providing off site access to FACP data that is necessary to manage fire system operation. A software package capable of uploading the detector sensitivity test results and the 1000 event system event buffer to the PC shall be required as part of the bid package. Communication shall take place over a direct connection to the PC and/or via the same telephone lines as the built in digital communicator. The facility management package must be separate from the downloader package and must not be capable of affecting programmed system options.

2.30 SERVICE REMINDER:
A. The FACP shall be capable of automatically generating textual service reminder and the main and remote annunciator LCD's to inform the user of required testing or service. The service reminder shall not interfere with the normal operation of the FACP.

2.31 ENGLISH LANGUAGE DESCRIPTIONS:
A. The FACP shall provide the ability to have a text description of each system device, input zone, and output group on the system. The use of individual lights to provide descriptions will not be acceptable except when used for remote annunciation.

2.32 ACCESSORY COMPONENTS:
A. The FACP shall support the following devices on the RS-485 data bus:
1. 5815XL Signaling Line Circuit Expander (SLC) Module
2. 5824 Printer Interface Module
3. 5860R LCD Remote Annunciator
4. 5865-3 LED Remote Annunciator
B. The FACP shall support the operation of 127 total devices per SLC loop without regard to device type. The following devices shall be supported:

1. SD505-APS Analog Photoelectric Smoke detector
2. SD505-AIS Analog Ionization Sensor
3. SD505-AHS Analog Heat Sensor
4. SD500-ARM Addressable Relay Module
5. SD500-AIM Contact input Module
6. SD500-MIM Mini Contact Input Module
7. SD505-DUCT Duct Detector
8. SD505-DUCTR Duct Detector with relay
9. SD500-ANM Addressable Notification Module
10. SD505-SDM Two Wire Smoke Detector Module
11. SD505-6IB Smoke Detector Isolation Base
12. SD505-6RB Smoke Detector Relay Base
13. SD505-6SB Smoke Detector Sounder Base
14. SD505-DTS-K Detector Test Switch for Duct Detector with Relay
15. SD500-PS Addressable Pull Station

C. The FACP shall support these other Silent Knight devices via addressable or conventional inputs.

1. PS-SATK Single Action Pull Station - Key Reset
2. PS-DATK Double Action Pull Station - Key Reset
3. PS-SA Single Action Pull Station (Lexan)
4. PS-DA Dual Action Pull Station (Lexan)

D. Furnish and install, where shown on the drawings, the following devices:

1. Manual Fire Alarm Stations:
   a. Manual Fire Alarm Stations shall be non-coded, break glass, single or double action type, with a key operated test-reset lock in order that they may be tested, and so designed that after actual emergency operation, they cannot be restored to normal except by use of a key. The reset key shall be so designed that it will reset manual station and open FACP without use of another key. An operated station shall automatically condition itself so as to be visually detected, as operated, at a minimum distance of fifty feet, front or side. Manual stations shall be constructed of die cast metal with clearly visible operating instructions on the front of the stations in raised letters. Stations shall be suitable for surface mounting on matching backbox, or semi-flush mounting on a standard single-gang box, and shall be installed within the limits defined by the Americans with Disabilities Act (ADA) dependent on manual station accessibility or per local requirements. Manual stations shall be Model SD500-PS. If using conventional pull stations they must be installed in conjunction with an Addressable Input Module (SD500-AIM or SD500-MIM) used with the manual stations. Manual Stations shall be Silent Knight Model PS-DATK, PS-SATK, PS-DA or PS-SA and Underwriters Laboratories listed when used with addressable modules.
2. Remote Power Supplies:
   a. The Remote Power Supplies for Notification appliances shall be the Silent Knight Models 5496 and/or RPS-1000. The 5496 and RPS-1000 Intelligent Power Supplies shall hang on the main S-Bus and be programmed through the IFP-1000 control. The 5496 will support 6 amps of 24 volt DC power with 4 notification circuits rated at 3 amps each. The RPS-1000 will support 6amps of 24 volt DC power, with 6 Flexput circuits, rated at 3amps each. Two additional 5815 SLC loop expanders shall be capable of being installed in the cabinet, to allow an additional 396 points. The power supply will also regenerate the S-Bus for an additional 6000’.
   b. The remote power supply model 5495 or 5499 may also be used on the system. These power supplies support 6amps or 9amps of 24VDC power with 4 notification circuits rated at 3amps each. These power boosters may also be activated from another notification circuit from either the fire alarm control or the Distributed Power Modules.

3. Notification Devices:
   a. The visual and audio/visual signaling devices shall be compatible with the IFP-1000, 5495, 5496, 5499, or RPS-1000 as stated in the installation manuals and be Listed with Underwriters Laboratories Inc. per UL 1971 and/or 1638. Each indicating appliance circuit shall be electrically supervised for opens, grounds and short circuit faults, on the circuit wiring, and shall be so arranged that a fault condition on any indicating appliance circuit or group of circuits will not cause an alarm to sound. The occurrence of any fault will light the trouble LED and sound the system trouble sounder, but will not interfere with the proper operation of any circuit which does not have a fault condition. The notification appliance (combination audio/visual units only) shall produce a peak sound output of 90dba or greater as measured in an anechoic chamber. The appliance shall be capable of meeting the candela requirements of the blueprints presented by the Engineer and ADA. The appliance shall be polarized to allow for electrical supervision of the system wiring. The unit shall be provided with terminals with barriers for input/output wiring and be able to mount a single gang or double gang box or double workbox with the use of an adapter plate. The unit shall have an input voltage range of 19-30 volts.
   b. Provide STI protective covers on all notification devices located in the gymnasium.

4. Smoke Detectors:
   a. All area detectors shall be the Silent Knight Model SD505-APS Analog Photoelectric Smoke Detectors. The base shall be the Silent Knight model SD505-6AB. The base may also include the SD505-6RB Relay Base where applicable. The Smoke detector shall have a flashing status LED for visual supervision. When the detector is actuated, the LED will produce quick flashes or latch on steady at full brilliance. The sensitivity of the detector shall be capable of being selected and measured by the control panel without the need for external test apparatus. The detector shall be a double EE-prom technology and be programmed using the internal programming loop located on the FACP.

5. Heat Detectors:
   a. Furnish and install analog/addressable heat detectors, Silent Knight model SD505-AHS. The combination heat detector and twist lock base shall be U.L. listed compatible with the Silent Knight IFP-100 fire alarm control panel.
   b. The base shall permit direct interchange with the Silent Knight SD505-AIS Ionization smoke detector and the SD505-APS photoelectric smoke detector. The base shall be appropriate twist lock base SD505-6AB.
   c. The heat detector shall have a flashing status LED for visual supervision. When the detector is actuated, the flashing LED will latch on steady at full brilliance. The detector may be reset by actuating the control panel's reset switch. The vandal security-locking feature shall be used in those areas as indicated on the drawings. Electronics of the unit shall be shielded to protect against false alarms from E.M.I. and R.F.I.
6. Duct Detectors:
   a. All Duct Detectors shall be Silent Knight Model SD505-DUCT or SD505-DUCTR housings with the Model SD505-AIS Ionization Smoke Detector. The SD505-DTS-K Remote Test Switch shall be provided where detector are not visible from the floor level.

2.33 SYSTEM WIRING:
A. The equipment supplier shall furnish to the installing contractor a complete detailed point-to-point wiring diagram showing the system equipment and required number, type and sizes of conductors and conduit sizes. Where common devices which break the alarm circuit are installed on a common zone with shorting type device, the circuit breaking devices shall be wired electrically downstream of the shorting type devices.

B. All fire alarm system wiring that is exposed; concealed in inaccessible locations (hard ceilings, for example); installed between floors; or that penetrates building smoke compartments shall be installed in an approved raceway. Fire alarm wiring routed horizontally in concealed accessible locations may be installed using approved plenum rated fire alarm cable provided it is supported in a manner consistent with Article 760 of the National Electrical Code, related Articles, and the manufacturers' installation documentation.

C. Basic wiring materials and installation shall comply with NFPA 70. All fire alarm system wiring shall be multi-conductor, UL-listed FLP for limited energy (300 volt) and fire alarm applications, and NEC approved fire alarm cable. Wiring shall be installed in accordance with NEC, local codes, Article 210 of NFPA Standard 72, and manufacturer's recommendations. All wiring shall be copper and installed in conduit sized in accordance with the National Electrical Code. Limited energy FPLP wire may be run open in return air ceiling plenums provided such wire is UL-listed to UL TEST 910 for such applications and is of the low smoke producing fluorocarbon type and complies with NEC Article 760-4(d) if so approved by the local authority having jurisdiction.

D. Fire alarm system wiring shall be color-coded in a manner acceptable to the Owner. System color coding shall be included in shop drawing submittals.

E. Where circuits are required to extend outside of the building, wiring shall be provided with primary protectors in accordance with NFPA 70 Article 760 and Article 800.

F. All fire alarm system junction boxes, including covers, shall be secured; painted red; and marked "FIRE ALARM" in white lettering by the electrical construction contractor as specified in Section 26 05 53, "Identification for Electrical Systems".

G. Conductor sizes shall be sized in accordance with NFPA 72 and NFPA 70 to provide the minimum required voltage drop. Calculations for voltage drops and circuit loading shall determine wire size. Minimum wire size shall for each circuit type be as follows:
   1. #18 AWG twisted and shielded for SLC voltage auxiliary control circuits.
   2. #18 AWG for non-data and communications initiating and low voltage auxiliary control circuits.
   3. #14 AWG twisted non-shielded for alarm/strobe circuits.
   4. #12 AWG for all power circuits.

H. Fire alarm system wiring shall not require shielding except for areas where the possibility exists for subjection to abnormal levels of RF or EMI. Fire alarm systems that are required to utilize shielded cables as part of the manufacturer's installation best practices shall not be acceptable for this project.

I. General Wiring Requirements:
   1. All wiring shall be in compliance with NEC, local building codes and Article 760 of NFPA Standard 70.
   2. Fire alarm conduits should not be used for any purpose other than fire alarm wiring. (No Exceptions)
3. All wiring shall be color coated and marked at each termination or junction box indicating the circuit served (i.e. power supply).
4. All wiring to use plenum rated cable installed in conduit – EMT for indoors and IMC for outdoors.
5. Horn/Strobe wiring shall be four wiring conductor cable to separate the strobe from the horn and ANSI purposes.

J. Connecting to or Modifying Existing Systems:
1. It is the responsibility of the Contractor to assure that there is no disruption of the facilities normal functions during construction such as studying, testing, class or administration.
2. Operating, modifying, and connecting to existing fire alarm systems shall be supervised and/or coordinated by the HISD Alarm Communications staff. Documentation indicating all changes shall be provided at the FACP at the time changes are made.
3. Existing systems shall remain operational during modifications or additions to the existing system throughout the duration of the project.
4. Where part or all of the existing fire alarm system is required to be demolished, remove the existing fire alarm components only after the new system installation is complete and accepted by the HISD Alarm Communications staff and AHJ.
5. Existing equipment that is required to be salvaged by the Owner shall be stored in a secure area designated by the Owner.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS:
A. Installation
1. FACP shall be located in the BCR (MDF).
2. All sub-panels shall be located in the BCR (MDF), FCR (IDF), electrical closet or mechanical rooms only.
3. All sensors shall be photo detection. All duct detectors shall be analog addressable ionization.
4. The equipment supplier shall furnish to the installing contractor a complete detailed point-to-point wiring diagram showing the system equipment and required number, type and sizes of conductors and conduit sizes. Where common devices which break the alarm circuit are installed on a common zone with shorting type device, the circuit breaking devices shall be wired electrically downstream of the shorting type devices.
B. All control panels and sub panels shall clearly indicate electrical breaker location, including room number, panel number and breaker number.
C. All horn strobes, speaker strobes or strobes only shall be wall mounted. Do not mount in ceiling unless approved by HISD Alarm Communications.
D. All final programming shall be completed using final room number graphics plan.
E. Provide annunciator panel in front office area.

3.2 INSPECTION:
A. Installer shall examine the areas and conditions under which the fire alarm system is to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

3.3 SYSTEM DESIGN:
A. General: The basic equipment and device locations have been shown on the Construction Documents. Specific wiring between equipment/devices has not been shown. It is the Contractor’s responsibility to submit for approval the COMPLETE ENGINEERED system configuration and layout showing all devices, wiring, conduit and locations along with other
required information as specified herein. The requirements and recommendations of NFPA 72 (2013), chapter 7, shall be provided as part of the submittal package without exception.

3.4 PROGRAMMING:

A. **General**: The manufacturer shall provide and install a menu driven software package, and shall provide all required programming of the system, including digitized voice alarms, graphics and action messages. Map and report formatting will be part of the software package. The software programming shall provide clear decision-making displays and text during critical alarm conditions that will allow the operator to make simple decisions during a crisis.

B. **Review**: A hard copy of all graphic map displays will be presented to the Owner for review. Before the manufacturer loads the program the Owner shall be given the opportunity to review and approve all textural displays, messages and system sequences. After programming is completed the Owner shall be given a demonstration, on a color monitor, of screen displays and sequences under various alarm conditions.

3.5 INSTALLATION:

A. **General**: Install system and materials in accordance with Manufacturer's instructions, roughing-in drawings, and details on the Drawings. Install electrical work and use electrical products complying with the requirements of the applicable Division 26 sections of these Specifications. Mount manual stations and alarm devices at heights specified in Section 26 05 01, “Electrical Basic Materials and Methods”.

B. **Wiring**: All wiring shall be in accordance with NFPA 72, the National Electrical Code, Local Codes, and Article 760 of NFPA Standard 70. All wiring sizes shall conform to recommendations of the equipment manufacturer, and as indicated on the engineered shop drawings.

1. Install fire alarm system line voltage and low-voltage wiring in a suitable raceway. Conceal fire alarm system conduit except in mechanical rooms and areas where other conduit and piping are exposed. Fasten flexible conductors, which bridge cabinets and doors, neatly along hinge side and protect against abrasion. Tie and support the conductors neatly.

2. All wiring shall be run in a supervised fashion (i.e. no branch wiring or dog-legged wiring) per NFPA requirements such that any wiring disarrangement will initiate the appropriate trouble signals via the main control panel per NFPA and UL requirements. Intelligent SLC loops may be T-tapped/branch wired due to inherent dynamic supervision.

3. Wiring splices shall be kept to a minimum with required splices to be made in designated terminal boxes or at field device junction boxes. Transposing or color code changes of wiring will not be permitted. End-of-line supervisory devices shall be installed with the last device on the respective circuit. Said device shall be appropriately marked designating it as the terminating device on the respective circuit.

4. No AC wiring or any other wiring shall be run in the same conduit as fire alarm wiring.

5. Number code and color code conductors appropriately and permanently for future identification and servicing of the system.

C. **Conduit/Raceway**: All wire shall be installed in an approved conduit/raceway system. Maximum conduit “fill” shall not exceed 40% per NEC.

1. Conduit and raceway system shall be installed as specified other Sections of the Specifications.

2. Minimum conduit size shall be 3/4" EMT. Install conduit per engineered shop drawings.

3. All vertical wiring and all main trunk/riser wiring shall be installed in a complete raceway/conduit system. All riser boxes shall be adequately sized for the number of conductors transversing the respective box as well as the number of terminations required.

D. **Labeling**: All system controls, indicators and other devices shall be labeled with names, designations and operating instructions as applicable. Labels shall be either engraved nameplates or covered printed labels and shall be approved by the Engineer. All water flow switches which are hidden shall have identification points. These identification points shall be red
tags with white lettering indicating location of the water flow switch. [Tag location will be visible from corridors.]

E. **Checkout:** Check wiring to ensure that wiring is in accordance with the system manufacturer's wiring diagrams and that the system is free of open circuits, short circuits, and grounds.

F. **Identification:** Refer to Section 26 05 51, “Identification of Electrical Systems”, for additional requirements concerning painting, nameplates, and labeling.

3.6 **COORDINATION:**

A. It shall be the responsibility of the installing contractor to coordinate all requirements surrounding installation of the fire alarm system with all trades. Adequate coordination shall be provided to ensure proper installation and interface to all peripheral items required to interact with the fire alarm to provide a complete and functional life safety system.

B. The installing contractor shall be fully responsible for coordinating all system and device messages and system operation with the Owner's Representatives and Operating Personnel.

3.7 **SYSTEM CHECKOUT AND TEST:**

A. A trained technical representative of the equipment supplier shall supervise the final control panel connections and testing of the system. Upon completion of the acceptance test the Abilene Christian University Maintenance Department will be instructed in the proper operation of the system.

B. The installation contractor shall functionally test each and every device in the entire system for purposes of operation and response. Written certification shall be provided upon completion of the test.

C. All final control panel connections shall be made by a state licensed, factory-trained technical representative of the manufacturer and who shall supervise a System Checkout and Test to demonstrate and confirm to the Engineer, Owner's Representative and the fire department, that the fire alarm system is 100% operational upon completion of the installation, and that it complies with all local code requirements and these specifications. It is intended that the System Checkout and Test be followed by a continuing program of inspection testing and maintenance. The Contractor shall provide a proposal to the Owner for a Maintenance, Inspection and Quarterly Testing Contract in compliance with NFPA 72H, upon completion and system checkout.

D. The System Checkout and Test shall be performed within 30 days after the fire alarm installation and all peripheral systems are completed. The System Checkout and Test shall be performed by a minimum of two licensed fire alarm system technicians, one of which is licensed by the State of Texas, and acceptable to the Engineer and the authority having jurisdiction. The test shall be performed in two parts and two-way radios for use by the test observers shall be provided. The first part shall be a full dry-run test with all subcontractors present, but without the Owner's Representative or fire department present. After the dry-run test is successfully completed, then the final test with the Owner's Representative and fire department present shall be performed.

E. This Contractor shall coordinate the test schedule with all necessary parties and subcontractors required to be present for a complete and functional test.

F. The System Checkout and Test which is a comprehensive 100% inspection and test of all fire alarm system equipment and shall include, but not be limited to the following:

1. **Fire Alarm Control Equipment:**
   a. A visual and functional test of all fire alarm control and auxiliary control equipment.
   b. A visual inspection shall be conducted to establish that all electrical connections and equipment as required are properly installed and operating.
   c. A remote functional fault simulation test shall be conducted on all relevant field wiring terminations to ensure that all wiring is properly supervised as required.
   d. All indicators shall be tested to ensure proper function and operation.
   e. All device messages shall be verified to be correct, as installed.
f. All system auxiliary functions including, but not limited to, CPU reporting, elevator recall, fire/ smoke door and shutter control, security interface, HVAC equipment control and shutdown, smoke control initiation, and other specified control functions shall be functionally tested to verify proper operation and proper system messages.

g. Control panel supervisory and alarm current readings shall be taken to verify that the control panel has the appropriate power supplies and standby batteries to operate the system as required. A 3 minute general alarm stress test both under ac power and standby power shall be conducted to further ensure complete operation of the system.

h. The Voice Communication System shall be visually and functionally tested to verify proper operation. Voice paging zoning shall be verified and automatic and manual operation of the voice paging system shall be fully verified. Self-monitoring functions of the voice paging system shall be verified.

i. The Firefighters’ Telephone System shall be functionally tested to verify proper zoning, supervision and operation of each firefighters’ telephone jack location.

j. The firefighters’ HVAC system override panel shall be 100% functionally tested to verify that all control switches and indicators function as specified.

2. Annunciators: All annunciators shall be tested to ensure that each point activates properly and labeling correctly defines the area of alarm.

3. Fire Alarm Peripheral Devices: All fire alarm peripheral devices shall be functionally tested and the location and testing information recorded for each device.

4. Initiating Devices (Manual and Automatic):
   a. All manual and automatic initiating devices shall be inspected to ensure proper placement and mounting as recommended by the manufacturer and as indicated in these specifications.

   b. All manual fire alarm stations and all automatic initiating devices (smoke detectors, heat detectors, waterflow switches, etc.) shall be functionally tested for alarm operation.

   c. A minimum of 10% of initiating devices shall be functionally tested for proper wiring supervision. Failure of any tested device on any zone shall require that all devices in that zone shall be tested for supervision.

   d. All device messages shall be verified to be correct as installed.

5. Alarm Signaling Devices:
   a. All visual alarm indicators and exit sign flashing shall be functionally tested to ensure proper operation and that they are clearly visible.

   b. Alarm signaling devices shall be field-checked and tested for proper operation and output.

   c. Decibel reading shall be taken to ensure that the alarm signal level can be clearly heard in all areas of the facility, if required by the authority having jurisdiction. Additional devices may be required to provide adequate sound penetration (or as required by the local authority having jurisdiction). Contractor shall provide a unit price for such devices should they be required.

   d. A minimum of 10% of the alarm signaling device shall be functionally tested for proper wiring supervision.

6. Reporting:
   a. Upon completion of the 100% System Checkout and Test, four copies of the final report shall be documented, certified, and sent to the Engineer for distribution to the Owner or authorized Owner's Representative indicating that all fire alarm equipment has been tested and is 100% operational.

   b. The final report shall be generated by the equipment manufacturers headquarters or authorized representative to ensure integrity and uniformity of all testing procedures and
reporting. The report shall contain the testing information, stating the precise location and operational status of each and every peripheral device and shall include a Fire Alarm System Certification and Description Document per NFPA 72.

3.8 TRAINING:
A. Upon completion of the installation, the equipment manufacturer shall furnish his services for a period of 8 hours of demonstration and training in the use of the system and its connected equipment. The 8 hour training period shall consist of operations and trouble shooting and technical trouble shooting of the fire alarm panel and system. All training shall be provided at the site.

3.9 AS-BUILT/RECORD DRAWINGS:
A. Two sets of manuals and as-built drawings shall be provided by the Contractor. The as-built drawings shall include a reproducible drawing and two copies of each as-built drawing. The drawings and manuals shall be used in the training sessions. At this time, manuals describing the system equipment, as-built wiring diagrams, system keys, and certification of a 100% system audit will be delivered to the Owner. Record drawings shall include, but not be limited to:
   1. As-built wiring and conduit layout diagrams incorporating wire color code and/or label numbers and showing all interconnections in the system.
   2. Actual locations of each input and output circuit termination, the identification marking of each circuit and the address of each device. Provide an input/output assignment chart. A unique identification number shall be assigned to each alarm initiating device. Identification should be by zone number permanently mounted adjacent to the device or its mounting base. Markings with felt tip pens will not be acceptable.
   3. As-built schematic wiring diagrams of all control panels, modules, annunciators and communications panels.
   4. As-built heat and smoke detector location drawings showing location dimension of each detector and alarm box.
   5. Copies of the manufacturers technical literature on all major parts of the system including detectors, manual stations, signaling appliances, alarm panels, communication panels and equipment and power supplies.
B. Refer to Section 26 00 01, “Electrical General Provisions”, for additional As-Built/Record Drawings requirements.

3.10 OPERATING AND MAINTENANCE DATA:
A. The manufacturer's authorized representative shall instruct the Owner's designated employees in the proper operation of the system and all required periodic maintenance. This instruction will include three copies of a written summary in booklet or binder form so employees can retain for future reference. Basic operating instructions for the system shall be framed and mounted at the main control unit. Refer to Section 26 00 01, “Electrical General Provisions”, for additional requirements.

3.11 WARRANTY:
A. The fire alarm and security systems shall be warranted against defects in workmanship and materials, under normal use and service, for a period of 2 years from the date of acceptance by the Owner. Any equipment shown to be defective shall be repaired, replaced or adjusted free of charge.
B. The warranty period shall begin after successful completion of the Owner's inspections and tests. In the event of any system malfunctions or nuisance alarms, the Contractor will take appropriate corrective action. This action may necessitate a repeat of the response test if the Owner so
desires. Continued improper performance during warranty shall be cause to require the Contractor to remove the system.

C. The warranty start date will not begin until after a period of 30 consecutive days of system operation without any nuisance alarms caused by malfunctioning of hardware of software.

3.12 WALK TEST

A. Notify the Owner, Architect and Engineer when system is 100 percent operational. Schedule walk-through of the entire facility and verify that each initiating and each indicating device is operating properly.

B. Provide report at conclusion of walk through certifying all fire alarm devices are working.

C. Walk test shall include a representative from owner maintenance department.

D. Walk test to show in a printed report all AHU shutdown, Sprinkler Tamper Report, Sprinkler Flow switch, strobes/horns, and smoke detectors. Report shall list all devices by approximate location to rooms, and device number. All duct detectors shall include flow differential at the detector as measured by a manometer. Manometer reading shall match manufacturer's specification for duct detector used.

3.13 SOFTWARE

A. Installer shall provide a backup copy of the installed program database (on DVD and CD) upon completion of the project. They shall also provide the current version of VeriFire-TCD (CD Software) for the panel provided.
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Removing existing vegetation.
   2. Clearing and grubbing.
   3. Stripping and stockpiling topsoil.
   4. Stripping and stockpiling rock.
   5. Removing above- and below-grade site improvements.
   6. Disconnecting, capping or sealing, and abandoning site utilities in place.

1.2 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.

D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.

E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.

F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.3 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site and legally disposed of.
1.4 INFORMATIONAL SUBMITTALS

A. Existing Conditions: Documentation of existing condition per Section 017300.

1.5 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.

B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises as shown on drawings.

C. Utility Locator Service: Notify Texas 811 for area where Project is located before site clearing.

D. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.

E. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."
   1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Protect existing site improvements to remain from damage during construction.
   1. Restore damaged improvements to their original condition, as acceptable to Owner.
3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 EXISTING UTILITIES

A. Contractor will arrange for disconnecting and sealing indicated utilities per the plans.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
   1. Arrange with utility companies to shut off indicated utilities.
   2. Owner will arrange to shut off indicated utilities when requested by Contractor.

C. Locate, identify, and disconnect utilities indicated to be abandoned in place.

D. Excavate for and remove underground utilities indicated to be removed.

E. Removal of underground utilities is included in earthwork sections; in applicable plumbing, electrical, communications, electronic safety and security and utilities section.

3.4 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
   1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
   2. Grind down stumps and remove roots larger than 2 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
   3. Use only hand methods or air spade for grubbing within protection zones.
   4. Chip removed tree branches and dispose of off site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
   1. Place fill material in horizontal layers not exceeding a loose depth of 6 inches, and compact each layer to a density equal to adjacent original ground.
3.5 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.
   1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
   1. Limit height of topsoil stockpiles to 72 inches.
   2. Do not stockpile topsoil within protection zones.
   3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
   4. Stockpile surplus topsoil to allow for respreading deeper topsoil.
   5. Stockpile soils shall have silt fence installed around the perimeter of all piles.
   6. Stock piled soil not used at the end of construction shall be hauled off site and disposed offsite at no additional cost to the owner.

3.6 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
   1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
   2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000
SECTION 312000

EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Excavation and Fill for site improvements (pavements, trails, walkways).
2. Excavation and Fill for building foundations.
3. Excavation and Fill for utilities.

1.2 DEFINITIONS

A. Base Course: Aggregate layer placed between the stabilized subgrade course and hot-mix asphalt paving. The base course shall comply with TxDOT Standard Specification No. 247.

B. Borrow Soil: Fill imported from off-site. The source of all imported fill material and the location of all borrow sites for fill material shall be submitted by the Contractor and approved in advance by the Owner.

C. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.

D. Fill: Soil material (on-site or borrow) used to raise existing grades and to backfill excavations. Fill soil material shall be low-plasticity, clayey sands (SC) or lean clays (CL) free of organics, debris and deleterious materials. Fill soil material shall have a liquid limit (LL) of less than 40, a plasticity index (PI) between 10 and 20, and no more than 35% of the soil particles passing the No. 200 sieve. The source of all imported fill material and the location of all borrow sites for fill material shall be submitted by the Contractor and approved in advance by the Owner.

E. Stabilized Subgrade Course: Lime stabilized layer placed between the subgrade and base course for hot-mix asphalt pavement or below reinforced concrete pavement. The stabilized subgrade course shall comply with TxDOT Standard Specification No. 260 and have 6% lime by dry weight.

F. Subgrade: Uppermost surface of an excavation or the top surface of a fill immediately below stabilized subgrade course, drainage fill, drainage course, or topsoil materials.

G. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.
1.3 SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Fill Material and Borrow Pit Locations: The source of all fill material and the location of all borrow sites for fill material shall be submitted by the Contractor and approved in advance by the Owner.

C. Material Test Reports: For each on-site and borrow soil material proposed for fill as follows:
   1. Classification according to ASTM D 2487.
   2. Laboratory compaction curve according to ASTM D 698.

D. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.4 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjacent occupied or used facilities during earth moving operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner.

B. Utility Locator Service: Notify "One Call" for area where Project is located before beginning earth moving operations.

C. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures are in place.

D. The following practices are prohibited within protection zones:
   1. Storage of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Foot traffic.
   4. Erection of sheds or structures.
   5. Impoundment of water.
   6. Excavation or other digs unless otherwise indicated.
   7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

E. Do not direct vehicle or equipment exhaust towards protection zones.

F. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.
PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Provide imported fill only from Owner-Approved borrow sources.

B. Fill soil material (on-site and imported) shall be low-plasticity, clayey sands (SC) or lean clays (CL) free of organics, debris and deleterious materials. Fill soil material shall have a liquid limit (LL) of less than 40, a plasticity index (PI) between 10 and 20, and no more than 35% of the soil particles passing the No. 200 sieve. The source of all imported fill material and the location of all borrow sites for fill material shall be submitted by the Contractor and approved in advance by the Owner.

C. Sand: ASTM C 33; fine aggregate.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

D. Contractor shall remove all site vegetation, major roots systems, topsoil, vegetation cover, deleterious materials, concrete slabs, abandoned underground structures/foundation systems and abandoned buried pipelines/conduits in their entirety from beneath the project areas scheduled for new construction. Site clearing activities should extend 5 feet beyond the new building and pavement perimeters.

3.2 CARE AND CONTROL OF WATER

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

C. Grade project area to route surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
3.3 EXCAVATION

A. For the Group Recreation Hall and new Comfort Stations, excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered to a distance of five (5') feet outside of building perimeter. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

3.4 SUBGRADE INSPECTION

A. Notify Owner when excavations have reached required subgrade. Owner's testing lab will observe the subgrade prior to proof rolling to determine acceptable soil conditions.

B. Exposed subgrade soils beneath proposed building footprints and pavement areas should be proofrolled with a pneumatic tire roller, or fully loaded tandem-axle dump truck or similar equipment with a minimum weight of 15 tons. No less than two complete coverages should be completed, with alternating perpendicular directions, of the proofroll equipment operating at a travel speed of no more than 3 mph. Any ground areas that either deflect, rut or pump under the traffic of the proofroll equipment shall be removed and replaced with fill. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted fill as directed.

C. Authorized additional excavation and corresponding fill will be paid for according to Contract provisions for changes in the Work.

D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Owner, without additional compensation.

3.5 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated unsatisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees. All stockpiled spoils shall be protected by silt fencing.

3.6 FILL

A. Place and compact fill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.

2. Removing concrete formwork.

3. Removing trash and debris.

B. Do not place fill on subgrades containing mud, frost, snow, or ice.
3.7 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.8 COMPACITION OF FILL

A. Place fill soil materials in horizontal loose layers not more than 6 inches in depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of Standard Proctor Maximum Dry Density according to ASTM D 698:

1. Under structures, building slabs, steps, and pavements, scarify and proof roll existing subgrade and compact each layer of fill soil material at 95% Standard Proctor Maximum Dry Density.
2. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent Standard Proctor Maximum Dry Density.

3.9 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

3.10 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material and maximum lift thickness comply with requirements.
3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.

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

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.

E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved Areas: At subgrade and at each compacted fill layer, at least one test for every 1000 sq. ft or less of paved area, but in no case fewer than three tests.

2. Buildings: At subgrade and at each compacted fill layer, at least one test for every 2,500 sq. ft or less of building footprint, but in no case fewer than three tests. Field density tests should be performed on the compacted fill at a frequency of one test for each 2,500 square feet of building pad area fill per lift of fill and one test at each shallow foundation location per lift of fill.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.11 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.12 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000
PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION:

This section specifies performance of dewatering required to lower and control ground water table levels and hydrostatic pressures to permit excavation, backfill, and construction to be performed in the dry. Control of surface water shall be considered as part of the work under this specification.

1.3 SUMMARY:

A. The work to be completed by the Contractor includes, but is not necessarily limited to the following:
   1. Dewater excavations, including seepage and precipitation.
   2. All water discharged from de-watering activities shall be filtered thru a filter sock and silt fence prior to leaving the work area.

B. The Contractor shall be responsible for providing all materials, equipment, labor, and services necessary for care of water and erosion control. Excavation work shall not begin before the Erosion and Sedimentation Control Plan is in place.

1.4 REQUIREMENT:

A. Dewatering system shall be of sufficient size and capacity necessary to lower and maintain ground water table to an elevation at least 1 foot below lowest foundation subgrade or bottom of pipe trench and to allow material to be excavated in a reasonably dry condition. Materials to be removed shall be sufficiently dry to permit excavation to grades shown and to stabilize
excavation slopes where sheeting is not required. Operate dewatering system continuously until backfill work has been completed.

B. Reduce hydrostatic head below any excavation to the extent that water level in the construction area is a minimum of 1 foot below prevailing excavation surface.

C. Prevent loss of fines, seepage, boils, quick conditions or softening of foundation strata.

D. Maintain stability of sides and bottom of excavation.

E. Construction operations are performed in the dry.

F. Control of surface and subsurface water is part of dewatering requirements. Maintain adequate control so that:
   1. The stability of excavated and constructed slopes are not adversely affected by saturated soil, including water entering prepared subbase and subgrades where underlying materials are not free draining or are subject to swelling or freeze-thaw action.
   2. Erosion is controlled.
   3. Flooding of excavations or damage to structures does not occur.
   4. Surface water drains away from excavations.
   5. Excavations are protected from becoming wet from surface water, or insure excavations are dry before additional work is undertaken.

G. Permitting Requirements: The contractor shall comply with and obtain the required State and County permits where the work is performed.

1.4 RELATED WORK:

A. Excavation, backfilling, site grade and utilities: Section 312000, Earth Moving.

1.6 SUBMITTALS:

A. Drawings and Design Data:
   1. Submit drawings and data showing the method to be employed in dewatering excavated areas 30 days before commencement of excavation.
2. Material shall include: location, depth and size of wellpoints, headers, sumps, ditches, size and location of discharge lines, capacities of pumps and standby units, and detailed description of dewatering methods to be employed to convey the water from site to adequate disposal.

3. Include a written report outlining control procedures to be adopted if dewatering problem arises.

4. Capacities of pumps, prime movers, and standby equipment.

5. Design calculations proving adequacy of system and selected equipment. The dewatering system shall be designed using accepted and professional methods of design and engineering consistent with the best modern practice. The dewatering system shall include the deep wells, wellpoints, and other equipment, appurtenances, and related earthwork necessary to perform the function.

6. Detailed description of dewatering procedure and maintenance method.

7. Materials submitted shall be in a format acceptable for inclusion in required permit applications to any and all regulatory agencies for which permits for discharge water from the dewatering system are required due to the discharge reaching regulated bodies of water.

B. Inspection Reports.

C. All required permits.

PART 2 - PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 INSTALLATION:

A. Install a dewatering system to lower and control ground surface water in order to permit excavation, construction of structure, and placement of backfill materials to be performed under dry conditions. Make the dewatering system adequate to pre-drain the water-bearing strata above and below the bottom of structure foundations, utilities and other excavations.

B. In addition, reduce hydrostatic pressure head in water-bearing strata below structure foundations, utility lines, and other excavations, to extent that water levels in construction area are a minimum of 1 foot below prevailing excavation surface at all times.
3.2 OPERATION:

A. Prior to any excavation below the ground water table, place system into operation to lower water table as required and operate it continuously 24 hours a day, 7 days a week until utilities and structures have been satisfactorily constructed, which includes the placement of backfill materials and dewatering is no longer required.

B. Place an adequate weight of backfill material to prevent buoyancy prior to discontinuing operation of the system.

3.3 WATER DISPOSAL:

A. Dispose of water removed from the excavations in such a manner as:

1. Will not endanger portions of work under construction or completed.
2. Will cause no inconvenience to Government or to others working near site.
3. Will comply with the stipulations of required permits for disposal of water.
4. Will Control Runoff: The Contractor shall be responsible for control of runoff in all work areas including but not limited to: excavations, access roads, parking areas, laydown, and staging areas. The Contractor shall provide, operate, and maintain all ditches, basins, sumps, culverts, site grading, and pumping facilities to divert, collect, and remove all water from the work areas. All water shall be removed from the immediate work areas and shall be disposed of in accordance with applicable permits.

B. Excavation Dewatering:

1. The Contractor shall be responsible for providing all facilities required to divert, collect, control, and remove water from all construction work areas and excavations.
2. Drainage features shall have sufficient capacity to avoid flooding of work areas.
3. Drainage features shall be so arranged and altered as required to avoid degradation of the final excavated surface(s).
4. The Contractor shall utilize all necessary erosion and sediment control measures as described herein to avoid construction related degradation of the natural water quality.

C. Dewatering equipment shall be provided to remove and dispose of all surface and ground water entering excavations, trenches, or other parts of the work during construction. Each
excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

3.4 STANDBY EQUIPMENT:

Provide complete standby equipment, installed and available for immediate operation, as may be required to adequately maintain de-watering on a continuous basis and in the event that all or any part of the system may become inadequate or fail.

3.5 CORRECTIVE ACTION:

If dewatering requirements are not satisfied due to inadequacy or failure of the dewatering system (loosening of the foundation strata, or instability of slopes, or damage to foundations or structures), perform work necessary for reinstatement of foundation soil and damaged structure or damages to work in place resulting from such inadequacy or failure by Contractor, at no additional cost to Government.

3.6 DAMAGES:

Immediately repair damages to adjacent facilities caused by dewatering operations.

3.7 REMOVAL:

Insure compliance with all conditions of regulating permits and provide such information to the TPWD Inspector and/or Construction Manager. Obtain written approval from TPWD Inspector and/or Construction Manager before discontinuing operation of dewatering system.

END OF SECTION 312319
SECTION 313116
TERMITE CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
B. Related Requirements:
   1. Section 061000 "Rough Carpentry" for wood preservative treatment by pressure process.
   2. Section 061050 “Miscellaneous Carpentry”
   3. Section 076200 "Sheet Metal Flashing and Trim" for custom-fabricated, metal termite shields.

1.3 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components, and profiles for termite control products.
   2. Include the EPA-Registered Label for termiticide products.

1.5 INFORMATIONAL SUBMITTALS
A. Qualification Data: For qualified Installer.
B. Product Certificates: For each type of termite control product.
C. Wood Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:
1. Date and time of application.
2. Termiticide brand name and manufacturer.
3. Quantity of undiluted termiticide used.
4. Dilutions, methods, volumes used, and rates of application.
5. Areas of application.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located and who employs workers trained and approved by manufacturer to install manufacturer's products.

1.7 FIELD CONDITIONS

1.8 WARRANTY

A. Wood Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work consisting of applied wood termiticide treatment will prevent infestation of subterranean termites, including Formosan termites (Coptotermes formosanus). If subterranean termite damage is discovered during warranty period, repair or replace damage caused by termite infestation and treat replacement wood.

1. Warranty Period: 12 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain termite control products from single source from single manufacturer.

2.2 WOOD TREATMENT

A. Borate: EPA-Registered borate termiticide acceptable to authorities having jurisdiction, in an aqueous solution for spray application and a gel solution for pressure injection, formulated to prevent termite infestation in wood.

1. Manufacturers: Subject to compliance with requirements, undefined:
   a. Ensystex, Inc.
   b. Nisus Corporation.
   c. NovaGuard Technologies, Inc.
   d. or approved by TPWD Resource Coordinator.
   e.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.

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

3.2 PREPARATION

A. General: Prepare work areas according to the requirements of authorities having jurisdiction and according to manufacturer's written instructions before beginning application and installation of termite control treatment(s). Remove extraneous sources of wood cellulose and other edible materials, such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.

3.3 APPLYING WOOD TREATMENT

A. Wood Treatment: Apply wood treatment after framing, sheathing, and exterior weather protection is completed but before electrical and mechanical systems are installed.

B. Application: Mix borate wood treatment solution to a uniform consistency. Apply treatment at the product's EPA-Registered Label volume and rate for the maximum borate concentration allowed for each specific use so that wood framing, sheathing, siding, and structural members subject to infestation receive treatment. Apply treatment to the height of 8 feet above grade.

1. Framing and Sheathing: Apply termiticide solution by spray to bare wood and with complete coverage.

2. Exterior Uncoated Wood Trim and Siding: Apply termiticide solution to bare wood only when forecasted weather conditions indicate no precipitation or fog before application of seal coat. After 48 hours, verify that surface is sufficiently dry for seal coat and apply seal coat of paint as specified in .

3.4 PROTECTION

A. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

B. Protect termiticide solution dispersed in treated soils and fills from being diluted by exposure to water spillage or weather until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

3.5 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include six months’ full maintenance by skilled employees of termite-control-treatment Installer
manufacturer's authorized service representative. Include quarterly maintenance as required for proper performance according to the product's EPA-Registered Label and manufacturer's written instructions. Parts and supplies shall be manufacturer’s authorized replacement parts and supplies.

B. Continuing Maintenance Proposal: Provide from termite-control-treatment Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1. Include annual inspection for termite activity and effectiveness of termite treatment according to manufacturer's written instructions.

END OF SECTION 313116
PART 1 - GENERAL

1.1 SUMMARY

A. Related Documents:
   1. Drawings and general provisions apply to this Section.
   2. Review these documents for coordination with additional requirements and information that apply to work under this Section.

B. Section Includes:
   1. Provision of permanent excavation support systems, as indicated on Drawings.

C. Related Sections:

1.2 REFERENCES

A. General:
   1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
   2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
   3. Refer to Division 01 Section "General Requirements" for the list of applicable regulatory requirements.

B. Applicable ASTM International Standards

C. American Welding Society:
   1. AWS D1.1 - American Welding Society's "Structural Welding Code".

1.3 DESIGN REQUIREMENTS

A. The permanent excavation support systems shown on the Drawings have been designed to support limited temporary loads associated with construction as noted on the Drawings. Submit temporary surcharge loads prior to surcharge placement.

B. Design of the permanent excavation support system shall complement, and not substitute for or diminish, the obligations of Contractor for the furnishing of a safe place of work and for the protection of the work, structures, and other improvements.

1.4 SUBMITTALS

A. Submit under provisions of Division 01 Section "General Requirements."
B. Excavation Procedures: Written sequence and procedures for the proposed excavation and installation of the excavation support systems.

C. Calculations: Submit structural calculations necessary to verify adequacy of shoring systems for temporary loads associated with construction activities and for any conditions differing from those described on the Drawings.
   1. Calculations shall be stamped and signed by a licenses engineer in the State of Texas.

D. Certified mill tests for steel.

E. Refer to individual sections for required submittals for the following:
   1. Reinforcement.
   2. Concrete.

1.5 QUALITY ASSURANCE

A. Excavation Support System Subcontractor Qualifications: Minimum 10 years experience in providing support systems for excavations of comparable depth and configuration.

B. Preinstallation Conference: Present the sequencing and staging of the work to Owner’s Representatives, Testing Laboratory and representatives from subcontractors participating in this portion of the Work.

1.6 PROJECT CONDITIONS

A. Geotechnical Investigation Report is available in accordance with "Information Available to Bidders".

PART 2 - PRODUCTS

2.1 MATERIALS

A. Soldier Piles (if required for temporary shoring):
   1. Shapes and Plates: ASTM A36 or 572, Grade 50 steel members of sizes indicated on drawings.
   2. Fabrication: Welding and welders shall conform to requirements of AWS D1.1.
   3. Finishing:
      a. Grind corners to minimum 1/16-inch chamfer.
      b. Prepare steel surfaces in accordance with SSPC-SP10, "Near White Blast Cleaning".
      c. After fabrication, shop prime paint with water-based inorganic zinc silicate primer to minimum 3 mils dry film thickness. Primer paint shall conform to SSPC Paint 20, Type I; Dimecote 21-5 by Ameron or equal.

B. Headed Studs: AWS D1.1, Type B, with appropriate ferrule for welding to vertical surfaces. Nelson S3L Shear Connectors, or equal.

C. Touch-up paint: Zinc-rich coating as recommended by paint manufacturer for field coating of abraded surfaces.
D. Permanent Tiebacks for wire mesh gabions shall be Screw-Type Anchor Systems at locations as stated in the drawings to a minimum embedment length of 96”. Anchor system shall consist of a screw anchor and 3/8” diameter stainless steel cable, T-304, 7x19 construction with 12,000 breaking strength. Basis of design is for screw anchor is Chance No-Wrench Screw Anchor #4345 or approved equivalent.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavation shall comprise and include the satisfactory loosening, removing, loading, transporting, depositing, and compacting in the final location all materials, wet and dry, necessary to be removed for purposes of installation of the permanent excavation support systems and such other purposes as indicated on the Drawings. Refer to Specification 312000 - Earth Moving.

3.2 REMOVAL OF WATER

A. Prevent surface runoff from flowing into excavation.

B. Provide and maintain ample means and devices during construction, with which to promptly remove and dispose of water entering the excavation or other parts of the Work, whether the water is surface water or groundwater.

3.3 SOLDIER PILES

A. Install piles per manufacturer’s recommendations and as designed for temporary shoring by a licensed engineer in Texas.

3.4 TIEBACK ANCHORS

A. Tieback Anchors: Provide tieback anchorage system as required on drawings.

3.5 FIELD QUALITY CONTROL

A. Testing Laboratory will (as required):
   1. Observe excavation and installation of excavation support system.
   2. Observe and monitor tests of tieback installation

B. Testing Laboratory will:
   1. Periodically inspect shop welding, field welding and welding of headed studs.
   2. Inspect and test reinforcing steel and concrete in accordance with requirements of applicable sections of specifications.

END OF SECTION 315000
SECTION 316000

RIPRAP

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Section includes requirements for furnishing concrete or stone riprap.

PART 2 - PRODUCTS

2.1 RIPRAP

A. Provide riprap consisting of broken concrete or stone blocks. Provide riprap which is dense, durable and hard material free from metal, cracks, seams and other defects which would increase deterioration from handling and natural causes. Place riprap on geotextile fabric.

B. Block Shape and Dimensions.

   1. Provide riprap blocks in cubic form, rather than elongated (flat) shapes.
   2. The minimum thickness of each block shall be 6 inches.
   3. No more than 25 percent of the blocks may have a length greater than 2 1/2 times the width or thickness. No length of block shall exceed 3 times the width or thickness.

C. Provide riprap well graded and conforming to Gradation No. 1 on Table No. 1 in this section.

D. Do not provide spalls, fragments and chips exceeding 5 percent by weight. The dimension and shape limitations do not apply to this portion of the riprap.

E. Where broken concrete is used, cut exposed metal, including rebar and wire mesh, flush with the surface of the block prior to placing the riprap.

PART 3 - EXECUTION

3.1 GRADE PREPARATION

A. Trim and dress the slopes to proper lines and grade prior to placement of riprap.

B. The Engineer may inspect prepared section prior to the placement of riprap.

3.2 RIPRAP PLACEMENT

A. Riprap shall meet the gradation and quality requirements as specified in Table 1 of this specification prior to placement.

B. Place the riprap to the slopes, lines, and grades as shown on the Plans, to establish a well-graded mass of riprap without voids.

C. Install riprap with minimum 24" thickness as shown on the Plans, with a minimum mat thickness as shown on the gradation tables.
D. Place the riprap in one course lifts. Place riprap carefully in such a manner to avoid displacement of damage to the prepared surface or geotextile. Place riprap in such a manner to avoid segregation of particle sizes. Place riprap as close to final position as feasible.

E. Place the riprap block in close contact, well-graded and free from pockets of small stones or clusters of large stones. Elongated riprap blocks shall be well distributed throughout the riprap mat. Individual oversized blocks are not permitted. These shall be broken to specified size or removed and replaced with riprap within the gradation limits. Surface irregularities shall be minimal.

F. Avoid dropping riprap from such height to cause breakage.

G. Prevent mixture or incorporation of dirt or other materials with the riprap during placing operation.

H. Placing of riprap by any method, machine or hand, will be permitted as long as specified requirements are obtained.

I. Fill spaces between larger riprap blocks with spalls and smaller blocks of the largest feasible size to form a compact mass. Do not place spalls and small blocks in place of larger size blocks.

### TABLE 1

<table>
<thead>
<tr>
<th>Light By Weight</th>
<th>Stone Weight Lbs.</th>
<th>Volume Cubic Ft (2)</th>
<th>Cubical Shape Ft (Each Side)</th>
<th>Spherical Shape Ft (Dia.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent</td>
<td>Lower Limit</td>
<td>Upper Limit</td>
<td>Lower Limit</td>
<td>Upper Limit</td>
</tr>
<tr>
<td>100</td>
<td>180</td>
<td>255</td>
<td>1.20</td>
<td>1.77</td>
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<tr>
<td>50</td>
<td>80</td>
<td>110</td>
<td>0.53</td>
<td>0.07</td>
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<td>15</td>
<td>40</td>
<td>60</td>
<td>0.27</td>
<td>0.40</td>
</tr>
</tbody>
</table>

**Note:**

1. The theoretical cube and sphere size is presented for guidance only. Paragraph 2.01 shall control riprap shape and dimensions.

2. Volume is based on 150 pcf, unit weight.

3. Provide a 24-inch thick mat, minimum, for Riprap Gradation No. 1.
AGGREGATE BASE COURSE

SECTION 321123

AGGREGATE BASE COURSE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION

A. This section describes furnishing and placing one or more courses of aggregate base on a prepared surface to the lines, grades, thicknesses, and cross sections shown on the drawings for pavement.

1.3 REFERENCES

A. AASHTO: American Association of State Highway and Transportation Officials
   1. AASHTO T027: Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates
   2. AASHTO T096: Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
   3. AASHTO T176: Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test

B. ASTM: American Society for Testing and Materials
   1. ASTM D1557: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³))
   2. ASTM D2041: Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
   4. ASTM D2922: Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

1.4 DEFINITIONS

A. Maximum Density Test (MDT): Theoretical maximum density of the bituminous mixture determined by multiplying the theoretical maximum specific gravity, determined by ASTM D2041, by 62.4 pounds per cubic foot.

B. Moving Average Maximum Density (MAMD): A moving five-test average of the most recent MDT’s. The moving average starts with the theoretical maximum density determined during the
mix design. The mix design density is included in the average until five MDT's have been completed.

1.5 SUBMITTALS

A. Submit aggregate qualification tests and product data in accordance with TxDOT Item 247 for aggregate used in aggregate base.

PART 2 - PRODUCTS

2.1 GENERAL

A. Aggregate shall Type A, Grade 2 per TxDOT Item 247.

2.2 AGGREGATE BASE

A. Dense-Graded Aggregate:

1. Grading: Dense-graded base aggregate shall be crushed rock, including sand. Uniformly grade the aggregates from coarse to fine. Sieve analysis will be determined in accordance with AASHTO T 27.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>2 1/2&quot;-0</th>
<th>2&quot;-0</th>
<th>1 1/2&quot;-0</th>
<th>1&quot;-0</th>
<th>3/4&quot;-0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Passing (by Weight)</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3&quot;</td>
<td>95-100</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 1/2&quot;</td>
<td></td>
<td>95-100</td>
<td>100</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>95-100</td>
<td>100</td>
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<td></td>
</tr>
<tr>
<td>1 1/4&quot;</td>
<td>5-75</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1&quot;</td>
<td></td>
<td>55-75</td>
<td></td>
<td>90-100</td>
<td>100</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td></td>
<td></td>
<td>55-75</td>
<td></td>
<td></td>
</tr>
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<td>3/8&quot;</td>
<td></td>
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</tr>
<tr>
<td>1/4&quot;</td>
<td>30-45</td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

* Of the fraction passing the 1/4 inch sieve, 40% to 60% shall pass the No. 10 sieve
3.1 AGGREGATE BASE COURSE

A. Hauling and Placing:
   1. Transport the aggregate to the work site, add water to obtain proper moisture content, and place on the prepared surface or material by means acceptable to the Port.

B. Thickness and Number of Layers:
   1. Base: If the required compacted depth of the base course exceeds 6 inches, construct it in two or more layers of nearly equal thickness. The maximum compacted thickness of any one layer shall not exceed 6 inches.
   2. Place each layer in spreads as wide as practical and to the full width of the course before a succeeding layer is placed.

C. Compacting and Shaping:
   1. Compact each layer of material placed in shoulder and base areas by rollers. Produce a uniform texture and firmly key the aggregates. Apply water over the materials for proper compaction according to these specifications. Continue compaction until there is no reaction or yielding observed under the compactor.
   2. Compact each lift to a minimum of 95 percent of maximum dry density as determined by ASTM D1557.
   3. Density of in-place compacted aggregate base course will be measured in accordance with ASTM D2922.

D. Surface Tolerance:
   1. The finished top of base course, when tested with a Contractor-furnished 12-foot straightedge, shall not vary from the testing edge by more than 0.04 foot at any point, and shall be within 0.04 foot of specified grade.

E. Field Testing:
   1. Testing of materials to be by Texas Parks and Wildlife laboratory.

END OF SECTION 321123
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. Cold milling of existing asphalt pavement.
   2. Hot-mix asphalt patching.
   3. Hot-mix asphalt paving.
B. Related Requirements:
   1. Section 312000 "Earth Moving" for subgrade preparation, fill material, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
   2. Section 321723: Pavement Markings

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include technical data and tested physical and performance properties.
   2. Job-Mix Designs: For each job mix proposed for the Work.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For manufacturer and testing agency.
B. Material Certificates: For each paving material. Include statement that mixes containing recycled materials will perform equal to mixes produced from all new materials.
C. Material Test Reports: For each paving material, by a qualified testing agency.
D. Field quality-control reports.

1.5 QUALITY ASSURANCE
A. Manufacturer Qualifications: A paving-mix manufacturer registered with/by TxDOT.
B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of 60 deg F.
2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D 692/D 692M, sound; angular crushed limestone.

C. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320, PG 64-22 and per TxDOT Item No. 300

B. Cutback Prime Coat: ASTM D 2027, medium-curing cutback asphalt, MC-30 or MC-70 and per TxDOT Item No. 310

C. Emulsified Asphalt Prime Coat: ASTM D 977 emulsified asphalt, or ASTM D 2397 cationic emulsified asphalt and TxDOT Item No. 310, slow setting, diluted in water, of suitable grade and consistency for application.

D. Tack Coat: ASTM D 977 emulsified asphalt, or ASTM D 2397 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

E. Water: Potable.

2.3 AUXILIARY MATERIALS

A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement; reclaimed, unbound-aggregate base material; and recycled asphalt shingles from sources and gradations that have
performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials. This item per TxDOT Item No. 305

B. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as “restricted use” for locations and conditions of application. Provide in granular, liquid, or wettable powder form.

C. Sand: ASTM D 1073, Grade No. 2 or No. 3.

D. Paving Geotextile: AASHTO M 288 paving fabric; nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications. This item per TxDOT Item No. 336.

2.4 MIXES

A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes designed according to procedures in AIMS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.

2. Provide mix in conformance with TxDOT Item No. 334.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph.
2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed.

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

3.2 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Herbicide Treatment: Apply herbicide according to manufacturer’s recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.
   1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.3 PLACING HOT-MIX ASPHALT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
   1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
   2. Place hot-mix asphalt surface course in single lift.
   3. Spread mix at a minimum temperature of 250 deg F.
   4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
   5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
   1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of mix along longitudinal joints.
   2. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.4 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
   1. Clean contact surfaces and apply tack coat to joints.
   2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
   3. Offset transverse joints, in successive courses, a minimum of 24 inches.
   4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
   5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
   6. Compact asphalt at joints to a density within 2 percent of specified course density.
3.5 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927, but not less than 94 percent or greater than 100 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.6 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3.7 FIELD QUALITY CONTROL

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

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.

2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.

   a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than three cores taken.

   b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION 321216
CONCRETE PAVING

SECTION 321313

CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD's Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Ramps.
   2. Landing.
   3. Parking lots.
   4. Curbs and gutters.
   5. Trails and Walks.

B. Related Requirements:
   1. Section 312000: Earth Moving
   2. Section 321123: Aggregate Base Course
   3. Section 311216: Asphalt Pavement
   4. Section 321723: Pavement Markings

1.3 DEFINITIONS

B. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

C. Reference Sheet Number C308, Detail 3 – Animal Track Stamps in concrete trail: Contractor shall submit a mock-up panel, one for each of the five (5) different animal track stamps for review and approval by Architect prior to stamping on proposed trail.

D. Other Action Submittals:
   1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.

B. Material Certificates: For the following, from manufacturer:
   1. Cementitious materials.
   2. Steel reinforcement and reinforcement accessories.
   3. Admixtures.
   4. Curing compounds.
   5. Applied finish materials.

C. Material Test Reports: For each of the following:
   1. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkalai-aggregate reactivity.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.

B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94 requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

C. Testing Agency: The Owner will employ a materials testing laboratory qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

D. ACI Publications: Comply with ACI 301 unless otherwise indicated.

1.7 PROJECT CONDITIONS

A. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials and 55 deg F for water-based materials, and not exceeding 95 deg F.
PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615, Grade 60; deformed and per TxDOT Item No. 440.

B. Tie Bars: ASTM A 615, Grade 60, deformed and per TxDOT Item No. 360.

C. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

   1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

   2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

2.3 CONCRETE MATERIALS – PER TXDOT ITEM NO. 421

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:

   1. Portland Cement: ASTM C 150, white portland cement Type I/II

B. Normal-Weight Aggregates: ASTM C 33, Class 4M, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.

   1. Maximum Coarse-Aggregate Size: 1 inch nominal.

   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: Potable and complying with ASTM C 94/C 94M.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain no more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

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

   a. ChemMasters.
   b. Davis Colors.
   c. Dayton Superior Corporation.
   d. Elementis Pigments.
   e. Hoover Color Corporation.
   f. Lambert Corporation.
   g. LANXESS Corporation.
   h. QC Construction Products.
   i. Scofield, L. M. Company.
   j. Solomon Colors, Inc.
   k. Stampcrete International, Ltd.
   l. SureCrete Design Products.

2.4 CURING MATERIALS – PER DMS-4640

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry or cotton mats.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Axim Italcementi Group, Inc.; Caltexol CIMFILM.
   b. BASF Construction Chemicals, LLC; Confilm.
   c. ChemMasters; Spray-Film.
   d. Conspec by Dayton Superior; Aquafilm.
   e. Dayton Superior Corporation; Sure Film (J-74).
   f. Edoco by Dayton Superior; BurkeFilm.
   g. Euclid Chemical Company (The), an RPM company; Eucobar.
   h. Kaufman Products, Inc.; VaporAid.
2.6 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752 and a synthetic polymer joint sealant per ASTM D5329 and ASTM C920.

   a. Sikaflex 1c-SL
   b. BASE Master Seal SL1

B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

   1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.7 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

   1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
   2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that meet or exceed requirements.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

   2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
   3. Slump Limit: 4 inches plus or minus 1 inch.
C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
   1. Air Content: 4-1/2 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size.
   2. Use water-reducing admixture in concrete as required for placement and workability.
   3. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M Furnish batch certificates for each batch discharged and used in the Work.

   1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgradients and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below proposed concrete paving to identify soft pockets and areas of excess yielding.

   1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
   2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
   3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 312000 "Earth Moving."

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

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT
A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

3.5 JOINTS
A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

   1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

   1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
   2. Provide tie bars at sides of paving strips where indicated.
   3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
   5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

   1. Locate expansion joints at intervals of 20 feet unless otherwise indicated.
   2. Extend joint fillers full width and depth of joint.
   3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
   4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
   5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
   6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-in radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.

   a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

   a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.

3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.


3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation steel reinforcement, and items to be embedded or cast-in.

B. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

C. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

D. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

E. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

   1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement dowels and joint devices.

F. Screed paving surface with a straightedge and strike off.
G. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

H. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

I. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

   1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

J. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

   1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
   2. Do not use frozen materials or materials containing ice or snow.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

K. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

   1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor’s option.
   2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
   3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

   1. Medium Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by curing compound as follows:
   1. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoff areas that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.9 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

   1. Elevation: 3/4 inch.
   3. Surface: Gap below 10-foot-long, unleveled straightedge not to exceed 1/2 in.
   4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
   5. Lateral Alignment and Spacing of Dowels: 1 inch.
   7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
   8. Joint Spacing: 3 inches.

3.10 FIELD QUALITY CONTROL

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

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

   1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

      a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

   2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.

5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.

6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

   a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.11 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Engineer.

B. Drill test cores, where directed by Engineer, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313
SECTION 321713

PARKING BUMPERS

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 wheel stops.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PARKING BUMPERS
A. Concrete Wheel Stops: Precast, steel-reinforced, air-entrained concrete, 4000-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners, transverse drainage slots on underside, and a minimum of two factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.

1. Surface Appearance: Free of pockets, sand streaks, honeycombs, and other obvious defects. Corners shall be uniform, straight, and sharp.

2. Mounting Hardware: Galvanized-steel dowel, 1/2-inch diameter, 10-inch minimum length.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Verify that pavement is in suitable condition to begin installation according to manufacturer's written instructions.

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

A. General: Install wheel stops according to manufacturer’s written instructions unless otherwise indicated.

B. Securely anchor wheel stops to pavement with hardware in each preformed vertical hole in wheel stop as recommended in writing by manufacturer. Recess head of hardware beneath top of wheel stop.

END OF SECTION 321713
SECTION 321723
PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes painted marking applied to asphalt and concrete pavement.

1.4 ENVIRONMENTAL REQUIREMENTS
A. Do not apply marking paint when weather is windy, foggy or rain, or ambient or pavement temperature are below 40 degrees F, nor when such conditions are anticipated during 8 hours after application.

1.5 REQUIREMENTS OF REGULATORY AGENCY
A. Work shall be constructed in accordance with all laws, ordinances, rules, regulations and orders of any public authority having jurisdiction. Contractor shall notify the Engineer before proceeding with the work where such work is required to be constructed in a manner differing from this section.

1.6 RELATED SECTIONS
A. Section 321313 – Concrete Paving.

PART 2 - PRODUCTS

2.1 MARKING PAINT
A. Marking material shall conform to TxDOT Standard Specification Item 666, Type II Marking Material, furnished in accordance with DMS-8200, 'Traffic Paint”. Color as identified on drawings.

PART 3 - EXECUTION

3.1 INSPECTION AND PREPARATION
A. Remove any existing pavement markings in accordance with TxDOT Standard Specification Item 677.

B. Locate markings as required by Drawings. Provide qualified technician to supervise equipment and application of markings and markers.
C. Lay out markings, using guide line, template, and forms.

D. Thoroughly clean surfaces free of soil, sand, gravel, oil and other foreign materials. Surface preparation for the installation of pavement markings and markers shall be in accordance with TxDOT Standard Specification Item 678.

3.2 APPLICATION

A. Pavement Markings shall be installed in accordance with TxDOT Standard Specification Item 666.

END OF SECTION 321723
CONCRETE UNIT PAVERS

SECTION 322000

CONCRETE UNIT PAVERS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Concrete unit pavers set in a sand bed atop a reinforced concrete subbase.

1.02 SUBMITTALS

A. Product Data: For materials other than water and aggregates.

B. Samples for concrete unit pavers. Provide 2 stones of each size & color.

1.03 QUALITY ASSURANCE

A. The Contractor is responsible for correction of work which does not conform to the specified requirements, including strength, tolerances and colors. Correct deficient materials as directed by the Owner.

B. Installer: A firm with a minimum of (3) three years experience in the successful installation of similar pavers in similar quantities. Firm must provide Owner a list of jobs completed which can be inspected by Owner or Project Manager. A minimum of 2 of these completed jobs must be located in the area similar to this job.

1.04 WARRANTY

A. Warrant the work specified herein for 1 year against becoming unserviceable or causing an objectionable appearance resulting from either defective or non conforming materials and workmanship.

1.06 PRODUCT HANDLING

A. Pavers shall be delivered and unloaded at jobsite on pallets and bound in shrink wrap plastics covers to prevent rust staining from steel strapping and in such a manner that no damage occurs to product during hauling, handling or unloading at the jobsite.

PART 2 - PRODUCTS

2.01 STONE UNIT PAVER

A. Concrete Unit Paver: Basis of Design is Keystone – Venetian, Winters Blend, Tumbled or approved equivalent. Sizes to be a combination of 12"x12", 6"x12", 6"x9" and 6"x6". Thickness shall be 2-3/8".

2.02 BEDDING MATERIALS

A. Sand: ASTM C 144.
PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

B. Cut pavers with motor-driven masonry saw equipment to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible.

C. Tolerances: Do not exceed 1/16-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches and 1/4 inch in 10 feet from level, or indicated slope, for finished surface of pavers.

3.02 CONCRETE SUBBASE

A. Provide 4-5/8" thick reinforced concrete subbase with #4 bars (continuous) at 12” on center each way. Slope to drain. See Specification Section 321313.

B. Install area drains and piping at the proper elevations to receive drainage from the patio area prior to placement of concrete.

3.03 SAND-BED APPLICATIONS

C. Remove water and debris from concrete subbase prior to placing sand.

D. Apply sand-bed over surface of concrete subbase to 1” in depth.

E. Place pavers on sand bedding adjoining one another.

F. Tamp pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.

G. Apply sand to the top of pavers and sweep into joints to achieve sand swept joints.

H. Cleaning: Remove excess sand from the pavers.

3.04 ATTIC STOCK

A. Unused pavers shall be palletized and provided to the Owner. A quantity approximately equal to 1% of the total project area for each color, size, and type of paver should be provided to the Owner for attic stock.

END OF SECTION 322000
SECTION 323120
ORNAMENTAL STEEL FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes: Ornamental welded steel fencing panels fabricated with galvanized flat bars and round rods welded into modular, open grille fencing panels, including steel fence posts and gates.

B. Related sections:

1. Section 033000 - Cast-in-Place Concrete: Concrete footings for support of fence posts.

1.3 REFERENCES

C. ASTM International (ASTM):

2. ASTM A36 – Carbon Structural Steel.

3. ASTM A121 – Metallic-Coated Carbon Steel Barbed Wire.

3. ASTM D3363 - Test Method for Film Hardness by Pencil Test.

1.4 SUBMITTALS

D. Provide the following submittals:

4. Product data for components and accessories.

5. Shop drawings showing layout, dimensions, spacing of components, and anchorage and installation details.

1.5 WARRANTY

A. Provide in warranty:

1. Factory finish: 20-year warranty against cracking, peeling, and blistering under normal use.

PART 2 - PRODUCTS

2.1 MATERIALS
ORNAMENTAL STEEL FENCES AND GATES

A. Steel bar stock:  ASTM A36.
B. Steel tubing:  ASTM A500, Grade B.
C. Grout:  Non-shrink type, pre-mixed compound consisting of non-metallic aggregate, cement, and water-reducing and plasticizing additives.

2.1 GATES
A. Provide gates of type and size indicated on Drawings.
B. Type:  Hinged swinging single gate.
   1. Construction:  Welded frame fabricated from steel tubing with open grille steel panels to match fencing material.
   2. Nominal size: per drawings.
   3. Hardware:
      a. Hinges: Per drawings with stainless steel roller bearings.
      b. Latch: Per drawings

2.5 FACTORY FINISH
A. Steel fence panels and posts shall be hot-dip galvanized to 1.25 ounces per square foot minimum zinc coating in accordance with ASTM A123. Standard size components shall receive polyester powder coating. Large gate panels shall be coated with 2-part polyurethane coating.

B. Polyester powder coating:  Electrostatically applied colored polyester powder coating heat cured to chemically bond finish to metal substrate.
   4. Minimum hardness measured in accordance with ASTM D3363:  2H.
   5. Direct impact resistance tested in accordance with ASTM D2794: Withstand 160 inch-pounds.
   6. Salt spray resistance tested in accordance with ASTM B117:  No undercutting, rusting, or blistering after 500 hours in 5 percent salt spray at 95 degrees F and 95 percent relative humidity and after 1000 hours less than [3/16 inch] [5 mm] undercutting.
   7. Weatherability tested in accordance with ASTM D822:  No film failure and 88 percent gloss retention after 1 year exposure in South Florida with test panels tilted at 45 degrees.

C. Polyurethane coating:  1.0 mil dry film thickness of coating of steel test panel cured 30 minutes at 180 degrees F and aged 14 days shall resist the following test conditions without failure:
   1. 5 percent salt spray for 500 hours.
2. 100 percent relative humidity for 1000 hours.

3. Water immersion for 100 hours.

4. 20 double rubs with cloth saturated with either lacquer thinner, acetone, MEK, gasoline, or xylene.

5. Exposure to lubricating oils, hydraulic fluids, and cutting oils.

6. 16 cycles of 24 hours at 100 percent humidity, 24 hours at 10 degrees F, and 24 hours at 77 degrees F.

7. Hardness: H to 2H.

8. Flexibility: [1/8 inch] [3 mm] conical mandrel.

D. Color: color as selected by TPWD.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prior to fabrication, field verify required dimensions.

3.2 INSTALLATION

A. Install fencing in accordance with manufacturer's installation instructions and approved shop drawings.

B. Install fence posts plumb and level by setting post in hole cast in concrete and grouting solid. Temporarily brace fence posts with 2 by 4 wood supports until grout is set.

C. Do not install bent, bowed, or otherwise damaged panels. Remove damaged components from site and replace.

D. Gates:

1. Install gates and adjust hardware for smooth operation.

2. After installation, test gate and operator. Open and close a minimum of five times. Correct deficiencies and adjust.

E. Touch-up damaged finish with paint supplied by manufacturer and matching original coating.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Furnishing, assembling and installing rock filled, PVC coated, welded wire mesh gabion baskets and mattresses.

1.2 TYPES

A. Gabions shall consist of rectangular or square wire mesh formed containers filled with rock. Gabions will conform to the following:

1. Welded wire mesh with a uniform square or rectangular pattern and a resistance weld at each intersection. The welded wire connections shall conform to the requirements of ASTM A185, including wire smaller than W1.2 (0.124 in.); except that the welded connections shall have minimum average shear strength of 70% and minimum shear strength of 60% of the minimum ultimate tensile strength of the wire. The wire mesh shall be galvanized before forming into mesh.

2. ASTM 974 as manufactured by Modular Gabion Systems, Houston, TX or approved equal.

B. Gabions. Gabions shall be furnished as baskets and mattresses. Baskets and mattresses shall be fabricated within a dimension tolerance of plus or minus 5%.

1.3 PAYMENT

A. Payment for the gabion baskets and mattresses is incidental to the lump sum amount for site work and includes excavation, preparation of the foundation and bedding material, PVC coated welded wire mesh baskets and mattresses, PVC coated lacing wire and spiral connectors, rock, riprap, screw-type anchorage and cable system, geotextile and lean concrete. Such payment will be considered full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work.

1.4 REGULATORY REQUIREMENTS

A. Conform to applicable codes.

1.4 RELATED SECTIONS


PART 2 - PRODUCTS

2.1 MATERIALS

A. Gabions shall be fabricated, assembled and installed in accordance with the nominal wire sizes and dimensions found in Table 1 using the following materials.

B. The overall sizes and locations of gabion baskets and mattresses and the anchorage and cable systems are shown on the drawings.
C. Wire for fabrication and assembly shall be hot-dipped galvanized. The wire shall have a minimum tensile strength of 60,000 psi. Galvanized steel wire shall conform to ASTM A 641, Class 3, and Soft Temper and PVC coated as described below.

D. The wire sizes include the galvanizing coating thickness.

E. The galvanized wire shall be coated by fusion bonded Polyvinyl Chloride (PVC) material. The wire coating shall be colored green, and the initial properties of the PVC coating shall meet the following requirements.

1. Specific Gravity. In the range of 1.30 to 1.40, ASTM D 792.
2. Abrasion Resistance. The percentage of weight loss shall be less than 12%, when tested according to ASTM D 1242, Method B at 200 cycles, CSI-A Abrader Tape, 80 Grit.
4. Tensile Strength. Fusion Bonded Coating (not less than 2275 psi. at 100 percent strain, ASTM D 638).
5. Modulus of Elasticity. Fusion Bonded Coating (not less than 1980 psi. at 100 percent strain, ASTM D 638).
6. Ultraviolet Light Exposure. A test period of not less than 3,000 hours, using apparatus type E at 63 C ASTM G 23.
7. Salt Spray Test. A test period of not less than 3000 hours, ASTM B 117.

C. After the exposure to ultraviolet light and the salt spray test as specified above, the PVC coating shall not show cracks, blisters, splits, nor noticeable change of coloring (surface chalk). In addition, the specific gravity shall not change more than six (6) percent, resistance to abrasion shall not change more than ten (10) percent, and tensile strength shall not change more than 25 percent from their initial values.

D. The wire sizes shown in Table 1 are the size of the wire after galvanizing and before coating with PVC.

E. Spiral binders are the standard fastener for welded-mesh gabion baskets and mattresses, and shall be formed from wire meeting the same quality and coating thickness requirements as specified for the gabion baskets.

### TABLE 1 (Minimum Requirements)

<table>
<thead>
<tr>
<th>Type of Wire</th>
<th>Mesh Size (inches)</th>
<th>Wire Diameter (as specified)</th>
<th>PVC Coating (inches)</th>
<th>Galvanized Coating oz./SF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lacing Wire</td>
<td></td>
<td>0.105 inches</td>
<td>0.02</td>
<td>0.70</td>
</tr>
<tr>
<td>Welded Wire Basket</td>
<td>3 x 3</td>
<td>9 gauge</td>
<td>0.025</td>
<td>0.80</td>
</tr>
<tr>
<td>Welded Wire Mattress</td>
<td>4 x 2</td>
<td>12.5 gauge</td>
<td>0.025</td>
<td>0.80</td>
</tr>
<tr>
<td>Spiral Binder</td>
<td>0.118 inches</td>
<td></td>
<td>0.02</td>
<td>0.80</td>
</tr>
</tbody>
</table>

NOTE: The wire sizes and PVC coating thickness shown are nominal sizes.
F. Standard fasteners must provide a minimum strength of 1,400 lbs. per lineal foot for gabion baskets and mattresses. When used to interconnect gabion baskets with PVC coating, spiral fasteners shall be PVC coated. All fasteners shall meet all of the closing requirements of the gabion manufacturer.

G. Rock shall conform to the quality requirements as follows and at least 85 percent of the rock particles, by weight, shall be within the specified river rock size range. For the gabion baskets, the minimum river rock dimension allowed is 5 inches and the maximum rock dimension allowed is 8 inches. For the gabion mattresses, the minimum river rock dimension allowed is 3 inches and the maximum rock dimension allowed is 5 inches. Color shall be light brown, light gray and tones/shades of brown. River rock shall weigh approximately 1.4 tons per cubic yard.

H. At least 30 days prior to delivery to the site, the Contractor shall inform the engineer in writing of the source from which the rock will be obtained, and include the test data and other information by which the material was determined by the Contractor to meet the specification. The Contractor shall provide the engineer free access to the source for the purpose of obtaining sampled for testing and source approval.

PART 3 - EXECUTION

3.1 FOUNDATION PREPARATION

A. The foundation on which the gabions are to be placed shall be cut or filled and graded to the lines and grades shown on the drawings. Salvaged cement bags shall be used for the foundation. Surface irregularities, loose material, vegetation, and all foreign matter shall be removed from foundation surface area. When fill is required, it shall consist of materials conforming to the specified requirements. Gabions and bedding or specified geotextiles shall not be placed until the foundation preparation is completed.

B. The surface of the finished material shall be to grade and free of mounds, dips or windrows. Extra care should be taken with foundation preparations in order to ensure a level and smooth surface. Geotextile shall be installed in accordance with the requirements of the plans and specifications.

3.2 ASSEMBLY AND PLACEMENT

A. The assembly and placement of gabions shall be in accordance with the following procedures.

B. Install Screw-Type Anchor Systems at locations as stated in the drawings to a minimum embedment length of 96”. Anchor system shall consist of a screw anchor and 3/8” diameter stainless steel cable, T-304, 7x19 construction with 12,000 breaking strength. Basis of design is for screw anchor is Chance No-Wrench Screw Anchor #4345 or approved equivalent.

C. Assembly. Rotate the gabion panels into position and join the vertical edges with fasteners for gabion assembly. Wrap lacing wire with alternating single and double half hitches at intervals between four (4) and five (5) inches. For spiral fasteners, one loop through each mesh opening for gabion mesh with the ends crimped to secure the spirals in place.

D. Connect gabion baskets and mattresses to screw-type anchorage systems as specified in the drawings, but not less than 12 feet on center. In addition, anchor the beginning and ending gabion baskets and mattresses for each run.
E. Interconnect each layer of gabions to the underlying layer of gabions along the front, back and sides. Stagger the vertical joints between the gabions of adjacent rows and layers by at least one-half of a call length.

3.3 FILLING OPERATION

A. After adjacent empty wire gabion units are set to line and grade and common sides properly connected, they shall be placed in straight-line tension to gain a uniform alignment. Staking of the gabions may be done to maintain the established proper alignment prior to the placement of rock. No temporary stakes shall be placed through geotextile material. Pre-formed stiffeners or connecting lacing wire shall be attached during the filling operation to preserve the strength and shape of the structure.

B. Internal connecting cross-tie wires shall be placed in each unrestrained gabion cell, including gabion cells left temporarily unrestrained. Two internal connecting wires shall be placed concurrently with rock placement, at each 12-inch interval of depth.

C. Crossties or stiffeners will be placed across the corners of the gabions (at 12 inches from the corners) providing diagonal bracing. Lacing wire or preformed wire stiffeners may be used.

D. The gabions shall be carefully filled with rock, either by machine or hand methods, ensuring alignment, avoiding bulges, and providing a compact mass that minimizes voids. At no point in the filling process may rock be mechanically placed from a height of over 36” from machine to fill area. Machine placement will require supplementing with handwork to ensure the desired results. The cells in any row shall be filled in stages so that the depth of the rock place in any one cell does not exceed the depth of rock in any adjoining cell by more than 12 inches. Along the exposed faces, the outer layer of stone shall be carefully hand placed with flat sides facing out and arranged to ensure a neat, compact placement with a uniform appearance with no edges of rock protruding through the welded wire.

E. The last layer of rock shall be uniformly hand leveled with flat sides facing out with no edges of rock protruding through the welded wire to the top edges of the gabions. Lids shall be placed over the rock filling using only approved lid closing tools as necessary. The use of crowbars or other single point leverage bars for lid closing is prohibited due to the potential for damage to the baskets.

F. The gabion lid shall then be secured to the sides, ends, and diaphragms with spiral binders or lacing wire wrapped with alternating single and double half-hitches in the mesh openings.

G. Any damage to the wire or coatings during assembly, placement and filling shall be repaired promptly in accordance with the manufacturer’s recommendations or the units shall be replaced with undamaged gabion baskets and mattresses.

END OF SECTION 323200
SECTION 323300

COIR LOGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

   A. This Section includes the following:

      1. Examination - Verifying fine grading is complete and ready to receive Coir
         Log installation.
      2. Preparation
      3. Excavation and Placement
      4. Maintenance
      5. Reconditioning existing lawn areas
      6. Replacing unsatisfactory or damaged Coir Logs
      7. Cleanup

1.3 MEASUREMENT AND PAYMENT

   A. No separate payment for Coir Logs shall be made. Include in the lump sum
      price for the Work.

1.4 SUBMITTALS/BIDDER QUALIFICATIONS

   A. Conform to Section 01300 - Submittals.

   B. Product data for the following:

      1. Coir Log

   C. Certification by manufacturer or vendor that the products supplied comply with
      Coir Log core, exterior net, and factory fabricated continuous coupler system
      including specified core and exterior net material properties, the date of Coir Log
      manufacture, and the location of coir log manufacture.

   D. Qualification data for firms and persons to demonstrate their capabilities and
      experience. Include lists of completed projects with project names and
      addresses, names and address of architects and owners, and other information
      specified. Submitting bidders must provide proof of five or more successful Coir
      Log installations. The submitting bidder must have a qualified representative from
      the vendor on site during installation. Vendor shall be available on an “as-
      needed” basis during construction.

   E. Coir Log installation schedule indicating order date as well as anticipated dates
      and locations for each type of activity.

1.5 QUALITY ASSURANCE
A. Qualifications - The Engineer’s approval of the erosion control system and the supplier will be based upon the following considerations:

1. The Coir Log for the erosion control system has been reviewed and approved for use.
2. The supplier has a large enough operation and the necessary experience to supply and support the construction on a timely basis.
3. The supplier has past experience in the construction of at least ten projects of a similar magnitude of the proposed system can be documented.

B. Installer Qualifications: Installer must have completed installation work of an erosion control system using similar materials and designs. Installer must have a record of successful establishment of the erosion control system. Installer is to document a minimum of five similar projects.

1. Installers Field Supervision: Require Installer to maintain an experienced full-time supervisor on the project site during times that Coir Log installation is in progress. Supplier shall be on site on an “as needed” basis.

C. The following testing and inspection requirements shall be certified by the manufacturer, vendor, and supplier, and inspected by the project engineer.

1. Weight of the Coir Log prior to vegetation will be equal to 9lbs/ft³ density uniformly machine compacted coir fiber at a maximum moisture content of 15%, with a maximum pith dust and foreign matter content of 3%.

2. Coir Log pieces shall measure 16” to 18” in diameter by 10’ in length as specified and indicated on Drawings.

3. Inspect all joints to ensure that there are no gaps or voids between adjacent Coir Log and that all exterior netting is continuous and that the factory-made integral and continuous coupler system has been secured and the voids between adjacent coir logs filled tightly with loose coir fiber.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver in a labeled, undamaged condition.

B. Deliver, store, and handle Coir Logs according to the requirements of the manufacturer, vendor, and supplier.

1.7 COORDINATION AND SCHEDULING

A. Coir Logs can be installed at any time of the year. Ordering, coordination, scheduling and release for shipping to be in accordance with the requirements of the manufacturer, vendor, and supplier.

B. Weather Limitations: Proceed with installation only when existing and forecast weather conditions are suitable for work.

PART 2 – PRODUCTS
2.1 MATERIALS

A. Coconut fiber – 100% bristle and mattress coir fiber
   1. Machined pressed uniformly compacted to 9lbs. /ft³
   2. Constant Head Permeability (ASTM D-2434) 16.3 cm sec⁻¹
   3. Hydraulic Transmissivity (ASTM D-4716) 9.15 gpm/ft
   4. Puncture Resistance (ASTM D-4833) 335.0 lbs.
   5. Moisture content 15% maximum.
   6. Pith dust and foreign matter content 3% maximum.

B. Exterior Netting – Knotless Virgin Polypropylene net exterior and factory fabricated integral and continuous coupler system shall have a rhombic opening and shall meet the following properties:
   1. Net Thickness (ASTM D-5199) 0.1 inches.
   2. Net Grab Tensile (ASTM D-4632) 250 lbs. minimum
   3. Net UV Resistance 250 kly
   4. Net Mesh bar length approximately 1.75 inches.

C. Anchoring Systems – Refer to Drawings.
   1. Hardwood Stakes and Rope Lashing

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive Coir Log installation for compliance with requirements and for conditions affecting performance of work of this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Verify the site is within 2 inches of specified grade. Verify that the soils in the location of the Coir Log anchor trench are sufficiently firm, i.e. less than one-half inch indentation with foot traffic. Also verify that rock or other structures associated with the erosion control system in the location of the Coir Log anchor trench are sufficiently anchored and placed at the proper elevation according to the plans and specifications and all manufacturers’ recommendations.

C. Verify that the location of Coir Log installation is clean and free of debris.

3.2 PREPARATION FOR COIR LOG INSTALLATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and native seed installations from damage caused by installation operations.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Remove rocks, sticks, roots, rubbish, and other extraneous matter from the location of Coir Log installation. Limit preparation to areas that will be installed promptly after preparation.
3.3 EXCAVATION AND PLACEMENT

A. Create a trench or seat to the dimensions and at the elevations specified by Drawings.

B. Place Coir Log in trenches or on seats, and at specified elevations, to ensure that there are no gaps or voids between adjacent Coir Logs and that all exterior netting is continuous and that the factory-made integral and continuous coupler system has been secured and the voids between adjacent coir logs filled tightly with loose coir fiber.

C. Install anchoring systems and secure Coir Logs in configuration and to dimensions as indicated by Drawings.

3.4 MAINTENANCE

A. Begin maintenance of Coir Logs immediately after installation is complete until acceptable vegetative cover is established.

B. Avoid mowing equipment and other deleterious operations such as herbicide application.

3.5 SATISFACTORY COIR LOG INSTALLATION

A. Coir Log installation will be satisfactory when requirements, including maintenance, have been met.

B. Repair or replace Coir Log areas that do not meet requirements and continue maintenance until satisfactory.

3.6 CLEANUP

A. Promptly remove soil and debris created by Coir Log installation. Clean wheels of vehicles before leaving site to avoid tracking soil onto surface of roads, walks, or other paved areas.

END OF SECTION 323300
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specifications Sections, apply to this Section.

1.2 SUMMARY

A. Work Includes:

1. Plant materials, limestone quarry blocks and benches, boulders, river rock, aggregates, installation, staking, edging, mulching, soil preparation and treatments, temporary irrigation and maintenance operations through the one-year warranty period of all rock, aggregate, sand trees, shrubs, ornamental grasses, ground covers and perennials as indicated on drawings and specified herein.

B. Related Requirements include the following:

1. Earth Moving Section 312000
2. Hydromulching Section 329213
3. Hydraulic Seeding Section 329219
4. Playground Equipment and Structures Section 124800

1.3 SUBMITTALS

A. Samples and Product Information: Representative samples or product information of the following materials shall be provided to the Landscape Architect from the supply source being used:

1. Plant material: Prior to digging and shipment by the nursery, contractor shall provide Owner with supplier, species and size information for all plant material and a representative photo of each proposed plant type for approval by the Landscape Architect. Once approved, the material photos will stand as the minimum acceptable standard for all like plant material.

2. Mulch: Product information and original delivery tickets or receipts
3. Organic matter: Product information and original delivery tickets or receipts.
4. Fertilizer: Product information and analysis.
5. River Rock: Product information and Gallon bag sample size
6. TreeGator bags – Product Information, single bag setup or approved equal
7. Filter Fabric: Product information
8. Limestone Quarry Blocks / Limestone Benches: Product information
9. Texas Moss Boulders: Product information
10. Pea Gravel: Product information 1 gallon sample
11. Sandbox Sand: Product information

B. Test Reports: Submit to the Engineer and Landscape Architect, two copies each of certified test reports for:

C. Certification
   1. Phyto-sanitary certification: All plant material inspection certificates required by federal, state, or other governing authorities will accompany each shipment and be turned over to the Owner and Landscape Architect upon delivery.
   2. Delivery Ticket: Original vendor's or grower's delivery ticket for each shipment of plants, soil amendments, and mulch shall show sizes, quantities, and root treatment of plants, i.e., containerized, balled and burlapped, or bare root.

D. Construction Schedule: Upon authorization to proceed with the work, submit two copies of the Construction Schedule indicating dates for the items of work.

E. Maintenance Instructions: Submit two copies of typewritten instructions recommending procedures to be established by the Owner for the maintenance of landscape work for an entire year. Submit prior to Notice of Substantial Completion.

F. Chemicals: Submit products, rates of application, and anticipated uses of pesticides, herbicides, and fumigants.

1.4 QUALITY ASSURANCE

A. Qualifications
   1. The Contractor shall be a company specializing in landscape installation.

B. All materials and work shall comply with applicable sections of the following references:

C. Source Quality Control
1. Certification: All landscape materials shall be from stock inspected and certified by authorized governmental agencies. The stock shall comply with governmental regulations prevailing at the supply source and the job site.

2. Analysis and standards: Products packaged in sealed containers shall be labeled with manufacturer’s certified analysis. The composition of bulk materials shall be tested by an approved laboratory in accordance with procedures established by the Association of Official Agricultural Chemists, wherever applicable, or as specified by product specifications referenced herein.

3. Plant material selection: Prior to digging and shipment by the nursery, contractor shall provide Owner with supplier, species and size information for all plant material and a representative photo of every proposed plant type for approval by the Landscape Architect. Once approved, the material photos will stand as the minimum acceptable standard for all like plant material.

D. Substitutions

1. If specified landscape material is not obtainable, notify the Owner, who will identify alternate sources or substitutes.

2. Plants shall be supplied at the sizes specified. Plants of larger size may be used if acceptable to Landscape Architect and if sizes of roots or balls are increased proportionately.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Digging Plant Material

1. Plants shall not be dug at the nursery or approved source until the Landscape Architect has received (See Section 1.3, C, 3) and approved the plant material and the Contractor is ready to transport them from their original locations to the site of the work or acceptable storage location.

B. Transportation of Plant Material

1. Plants transported to the project in open vehicles shall be covered with tarpaulins or other suitable covers securely fastened to the body of the vehicle to prevent overheating of the plants.

2. Plants shall be kept moist, fresh, and protected at all times. Such protection shall encompass the entire period during which the plants are in transit, being handled, or are in temporary storage.

3. The roots of barefoot stock shall be protected from drying out with wet straw or other suitable material while in transit.

4. Unless otherwise authorized by the Owner or Landscape Architect, notify the Landscape Architect at least five working days in advance of the anticipated delivery date of any plant material. The original bill of loading, showing the quantities, kinds, and sizes of materials included for each shipment shall be furnished to the Owner and Landscape Architect.
C. Storage

1. Unless specific authorization is obtained from the Landscape Architect, plants shall not remain on the site of work longer than three days prior to being planted.

2. Plants that are not planted immediately shall be protected as follows:
   a. Root balls shall be kept moist and their solidity carefully preserved.
   b. Plants shall not be allowed to dry out or freeze.

3. Both the duration and method of storage of plant materials shall be subject to the approval of the Landscape Architect.

D. Handling of Plant Materials

1. Exercise care in handling plant materials to avoid damage or stress.

1.6 REJECTION OF MATERIALS

A. Evidence of inadequate protection following digging, carelessness while in transit, or improper handling or storage, shall be cause for rejection.

B. Upon arrival at the temporary storage location or site of the work, plants shall be inspected for proper shipping procedures. Should the roots be dried out, large branches be broken, balls of earth broken or loosened, or areas of bark be torn or damaged the Landscape Architect will reject the injured plant.

C. When a plant has been rejected, remove it from the area of the work and replace it with one of the required size and quality.

1.7 MAINTENANCE

A. Maintain plant material until the completion of the warranty period and Final Acceptance of work, as described in Part 3 of this section.

1.8 WARRANTY

A. Plants, stonework, fabric and all items under this section shall be warranted for a period of one year after the date of written approval of Substantial Completion by the Owner.

B. Plants shall be healthy, free of pests and disease, and in flourishing condition at the end of the warranty period. Plants shall be free of dead and dying branches and branch tips, and shall bear foliage of normal density, size, and color.

C. Replace dead plants and all plants not in a vigorous, thriving condition, as determined by the Owner and/or Landscape Architect within 30 days of notice and at the end of the warranty period as required, without cost to the Owner, as soon as weather conditions permit and within the specified planting period.

1. Replacements shall closely match adjacent specimens of the same species. Replacements shall be subject to all requirements stated in this Specification.
2. Make all necessary repairs due to plant replacements. Such repairs shall be done at no extra cost to the Owner.

3. The warranty of all replacement plants shall extend for an additional one-year period from the date of their acceptance after replacement. In the event that a replacement plant is not acceptable during or at the end of the said extended warranty period, the Owner may elect one more replacement or credit for each item.

D. At the end of the warranty period, and no less than five days prior to Final Inspection, staking materials shall be removed from the site where noted below under “Staking Materials”.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Plant Materials

1. Name and Variety: Provide plant materials true to name and variety described in "Hortus Third," Cornell University, 1976, or by cultivars generally accepted in the trade.

2. All plant material shall be No. 1 grade nursery stock grown in accordance with good horticultural practices. Plants shall be free of disease, insects, eggs, larvae, and defects such as knots, sunscald, injuries, abrasions, or disfigurement. They shall be sound, healthy, and vigorous, of uniform growth, typical of the species and variety, well formed, free from irregularities, with the minimum quality conforming to American Standard for Nursery Stock.

3. Plants indicated, as specimen shall be exceptionally heavy, symmetrical, and tightly knit, cultured, to be unquestionably superior in form, branching, compactness, and symmetry.

4. The minimum acceptable sizes of all plants shall be measured before pruning and with branches in normal position. Unless otherwise designated on the plant list, all plant dimensions shall conform to those listed in ANSI Z60.1, American Standard for Nursery Stock.

5. Branching point is the distance above ground where balanced branching occurs or where a dimension in trunk appears to form the head of the tree.

6. Root Treatment: Root treatments on all plants shall conform to the requirements of ANSI Z60.1. Plants shall be dug and prepared for shipment in a manner that will not cause damage to branches, shape, and future development after planting.

   a. Plants furnished in containers shall have the roots well established in the soil mass and shall have growth in the container for at least one growing season. Containers shall be large enough to provide earth-root mass of adequate size to support the plant tops being grown. For container-grown trees, container size shall provide a minimum of 9 inches of root
mass per caliper inch of trunk. Plants, other than ground covers, over-established in the container, as evidenced by pot-bound root ends, will not be accepted.

7. Plant materials shall be subject to final approval by the Landscape Architect at the job site.

B. Soil Amendments – (Delivery tickets shall be provided by contractor for measuring of quantities.)

1. Organic matter shall be “fully decomposed,” supplied by Living Earth Technology 972-869-4332 or approved equal.

2. Sand shall be clean, coarse, ungraded, meeting the requirements of ASTM C33 for fine aggregates.

3. Superphosphate shall be composed of finely ground phosphate rock, as commonly used for agricultural purposes, containing not less than 15 percent available phosphoric acid.

4. Fertilizer shall be granular fertilizer containing natural ingredients such as, but not limited to, composted manures, leather tankage and/or various meals, with a minimum percentage by weight of 3-1-2 nitrogen, available phosphoric acid, and potash. The following products are approved:
   a. GreenSense by Ideal Technologies, Inc., Irving, Texas.
   b. SUSTANE by Sustane Corporation, Chaska, Minnesota.
   c. Texas - Tee by Maestro-Gro.
   d. Approved equals as submitted by the contractor

5. Elemental sulphur shall be finely ground horticultural grade material containing at least 95 percent purity. Material shall be delivered in unopened containers containing manufacturer's warranty analysis.

C. Bark Mulch

1. Mulch material shall be finely shredded, fibrous hardwood bark mulch, free from other foreign material and partially decomposed, passing a 1 1/2 inch screen and free of growth or germination inhibiting ingredients supplied by Living Earth Technology 972-869-4332 or approved equal.

D. Filter fabric as used in in playground sandbox and under river rock border shall be DeWitt Pro5, or approved equal.

E. Staking Materials

1. Stakes shall be "Arbor Stakes" biodegradable, subsurface stakes or approved equal. Install per manufacturers direction. Stakes do not require removal.

2. Earth anchor kits may replace guying materials above as approved by the Owner and Landscape Architect. Earth anchors shall be cast alloy conforming to ASTM
3. ‘Safety Stake’ kits may be detailed and replace staking materials above as submitted and approved by the Landscape Architect. ‘Safety Stake’ mounting rings and ground stakes are as detailed in the planting plans. If utilized, Safety Stakes shall removed by Contractor and become the property of the Contractor at the end of the one year warranty period.

F. Tree Wrap: Not Allowed. Damaged or injured trees will be rejected.

G. Tree Paint: Tree paint shall be waterproof, asphalt base paint with antiseptic properties for use on existing tree wounds only and shall be TREE KOTE, Sherwin Williams Pruning Compound, or approved equal. Damaged or injured new trees will be rejected.

H. Herbicide and soil fumigant products and rates of application shall conform to registered uses.

   All sides are made watertight with durable 1/4" thick heat seals.

   The bag is secured to the tree with heavy-duty nylon zippers on sewn on to each side.

   Drip holes are cored through both ply of material to allow for adjustable drip times.

2.2 SOIL MIXES - (Delivery tickets shall be provided by contractor for measuring of quantities.)

A. Tree pit-planting mix:

   Tree pit back fill shall be 100% existing, native soil. Rock will not be considered native, backfill soil and should be substituted with an approved planting mix.

B. Shrub, ground cover and seasonal color beds shall be native soil with enriched compost comprised of organic matter and sand. Depth of bed as detailed in plans. Screened for maximum 1” particle size and blended for a uniform mixture, containing a minimum 45% organic material, supplied by Living Earth Technology, 972-869-9498 or approved equal.

C. Raingarden soil shall consist of 2 parts native soil, and 1 part organic compost

D. Raingarden sub soil around infiltration pipe shall consist of 1 part native soil, 1 part organic compost, 1 part expanded shale, and 2 parts sand for improved infiltration.

2.3 ANTIDESICCANT

A. Antidesiccant shall be an emulsion specifically manufactured for plant protection, which provides a protective film over plant surfaces, which is permeable enough to permit transpiration. Antidesiccant shall be delivered in manufacturer’s sealed containers and shall contain manufacturer’s printed instructions for use.

B. Antidesiccant shall be equal to the following:

   Product   Manufacturer
2.4 FUNGICIDE

A. Fungicide shall be "Bordeaux Mix," manufactured by Hi-Yield or approved equal.

2.5 ROCKS, BOULDERS, FLAGSTONE AND AGGREGATES

A. River rocks used for borders shall vary in size from 3" to 5" oval rock lengths. Widths of river rocks shall vary. Primary colors shall be shades of light brown and light gray. Medium browns and rusts colors shall be limited to less than 10% of the overall rock mix. Dark red, gray or black color rock will not be accepted.

B. Texas Moss Boulders shall range in size from ¼ to ½ ton. Size of boulders shall vary. Soil beneath boulder must be compacted prior to setting. The bottom 1/4 to 1/3 of boulders shall be buried to provide a naturalistic appearance and firmly secure them in place. Boulders shall be firmly in place and not wobble when stepped upon.

C. Flagstone as used to face the playground tunnel shall be 3” thickness minimum and match Texas Moss Boulders color. Outer sides shall be smooth and flat with no projections exceeding ½” height. Individual stone sizes shall vary.

D. Limestone Quarry Blocks / Limestone Benches as shown at the playground and along the trail shall be 24” x 24” x 72”. All quarry blocks shall have at least 1 smooth cut side, which should always be positioned as the top side.

E. Pea Gravel used within the proposed beach and for restoration of the existing beach shall match existing. Granules shall be no smaller than 1/8” and no larger than 1/4”. Granule colors may vary with shades of brown, gray and white.

F. Sand box Sand as used in the playground shall be shall be clean, coarse, and ungraded. Coarse builder sand or sharp sand are acceptable. Fine play sand is prohibited due to its susceptibility to erosion.

PART 3 - EXECUTION

3.1 VEGETATION REMOVAL

A. Strip existing aggregates, granites, edging, plant material, grass and weeds, including roots, from all bed areas, leaving the soil surface one inch below finished grade. All required tree pruning must be performed by a certified Arborist.

B. Herbicides: Apply specific herbicide to eradicate vegetation within bed areas.

3.2 PLANTING

A. Excavation
1. Rocks and other underground obstructions shall be removed to a depth necessary to permit proper planting according to plans and specifications. If underground utilities or other structural obstructions are encountered, the Landscape Architect will determine alternate planting locations.

2. Plant beds/pits shall be dug only by methods approved by the Landscape Architect.
   a. Spread approved compost across the planting bed area to a 4" depth and till to depths detailed and described in the planting plans.
   b. Planting pits shall be round, with vertical sides and flat bottoms, and sized in accordance with outlines and dimensions shown on the drawings.
   c. If rotating augers or other mechanical diggers are used to excavate holes, the vertical sides of the pits shall be scarified, fractured, or otherwise broken down to eliminate impervious surfaces.
   d. Loosen or scarify in the bottom of all plant pits to a depth of 4 inches.
   e. Over excavate the tree pits to remove an additional 12 inches of impervious materials.

3. Excavated material that is not conductive to plant growth will not be used for backfill in any planter or planting pit and shall be removed to an area designated by the Owner or Owner Representative.

4. PERCOLATION TESTS: Dig each tree and plant pit in accordance with the required details. Fill each hole with water and wait for 24 hours. If the planting pit is absent of water after the 24 hour waiting period, planting may commence. If not, notify the Owner and Landscape Architect. Additional drainage elements may be required.

B. Planting

1. Trees: Place a compacted planting mixture in the bottom of the pit or to depth necessary to set the plant 2 inches above finished grade to insure that the root flare is not covered. Set the plant in the pit to the proper grade and position, faced to give the best appearance or relationship to one another and adjacent structures. Cut away burlap, rope, wire, or other wrapping materials from the top of the ball and remove. Do not remove burlap or ties from sides or bottom of ball. If plastic wrap or other non-degradable materials are used in lieu of burlap, completely remove them before placing of backfill. Cleanly cut off broken or frayed roots and sever the sides of the root ball of container-grown trees in several places. Slowly move away wrapping roots from the tree flare or ball and direct root away from tree. Place native soil or planting mixture (in cases of rock) around the ball and carefully compact to avoid injury to the roots and to fill the voids. After backfilling planting pit approximately two-thirds full, add water and allow planting mixture to settle. After the water has been absorbed, fill the planting pit with additional native soil or planting mixture. Tamp lightly to grade, place a 1-inch layer of organic matter over planting mixture, and form a watering basin of the size indicated on the drawings. Do not cover the tree root flare.
2. Trees planted in areas without permanent, underground irrigation shall be irrigated with Treegators (single bag setup for 2"-3" caliper shade trees) – slow release watering bags or approved equal.

3. Container-grown shrubs, ground cover, and vines: Remove containers before planting and sever the sides of root ball in several places, loosening the roots on the outside of the ball sufficiently to encourage rapid root extension into the surrounding soil and to prevent girding of root mass.

4. Restrictions: Do not plant when ground is frozen, snow covered, saturated or in otherwise unsuitable condition for planting. Special conditions may exist that warrant variance in specified planting dates or conditions. Submit written request for approval to COR stating special conditions and proposal variance.

   a. Do not plant trees, shrubs, groundcovers, or perennials during drought months between June 1 and September 1.

   b. Install Bermuda Hydromulch between April 15 and September 15, when average temperatures are between 75 to 85 degrees or higher for first 5 to 6 weeks. See 329213 Hydromulching

   c. Native seed may be planted yearround, provided a cover crop is included during winter months. See 329213 Hydraulic Seeding.

C. Mulching

   1. Mulching shall take place within 48 hours after planting.

   2. Mulch plant beds, tree, and shrub planting pits to a uniform depth of 3 inches.

   3. Mulch shall be kept out of the crowns of shrubs, away from tree trunks, and off buildings, sidewalks, light standards, and other structures.

D. Pruning

   1. Trees

      a. All tree pruning shall be performed by a certified Arborist. Prune trees by removing all dead wood, badly formed crossing limbs, and any other growth to insure healthy and symmetrical growth of new wood. Up to one-third of the branches may be removed. The proportion is, in all cases, subject to the approval of the Owner and Landscape Architect.

      b. In the case of multiple leaders, preserve the one which will best promote the symmetry of the tree, and remove or cut back the remainder so that they will not compete with the selected leader. Cut back surrounding top branches to conform to the leader.

      c. Paint cut surfaces over one inch in diameter with tree wound dressing.

   2. Shrubs
a. Prune shrubs by removing all dead wood and broken branches, thinning out canes and cutting back or removing unsymmetrical branches. Pruning shall result in a loose outline conforming to the general shape of the shrub type. Do not use hedge shears.

E. Wrapping: Not Allowed

F. Staking

1. Staking operations shall be completed as shown on the drawing details immediately after planting.

G. Edging

1. Concrete edging shall be installed at locations indicated on the Drawings. Where required, edging shall be cut square and accurately to required length.

2. Top of edging shall be set 3/4 in. above finished grade.

H. Maintenance

1. The maintenance period shall commence when the written Notice of Substantial Completion is issued and shall continue as required until the end of the warranty period.

2. Plants shall be inspected at least once per week by the Contractor during the installation period and needed maintenance performed promptly. Monthly inspections should occur in the cool season and biweekly inspections in the warm season, during the one year warranty period.

3. The Contractor shall irrigate all plants adequately to maintain optimum supply of moisture within the root zone; recurring overly dry or wet conditions shall be grounds for rejection of plant material. If the irrigation system is inoperative, hand watering shall be accomplished from a source approved by the Owner. Water shall not be applied with a force that will displace mulch or cause soil erosion and shall not be applied so quickly that it cannot be absorbed by the mulch and plants.

4. Plants shall be pruned and mulch replaced as required.

5. Stakes and guys shall be adjusted or replaced as required. Repair eroded or damaged plant saucers.

6. Maintain all plant beds and saucers weed free at all times.

7. Keep plants free of insects and disease. All insecticides and fungicides applied to control pests and maintain plants in a healthy growing condition shall be approved by the Owner.

8. Fertilize plants at least twice during the warranty period. Fertilization shall be applied by topdressing 1 pounds per 100 square feet of bed area, and 1 to 2
pound each tree. Fertilizer for the application shall be a controlled release type used for the installation.

9. Remove, at no cost to Owner, dead and unacceptable plants, as their condition becomes apparent. A dead or unacceptable plant is defined by more than 20% of the foliage or branches are dead.

10. Fill gatorbags 2X per week as directed by the manufacturer. Maintain the watering schedule through project acceptance and through the 1 year warranty period.

3.3 APPLICATION OF FERTILIZER

A. Organic Fertilizer: Planting beds shall be fertilized two times per year (March and October) with Organic Fertilizer at a minimum rate of 10 lb. per 1,000 square ft. Rate of application shall be varied depending on fertilizer type used, weather conditions, and overall soil conditions to produce a consistent growth and color to the plantings. After application of fertilizer, planting beds shall be thoroughly watered.

3.4 CLEANUP AND PROTECTION

A. Cleanup

1. Excess and waste material shall be removed daily.

2. When planting in an area has been completed, the area shall be cleared of all debris, soil piles, and containers.

3. At least one paved pedestrian access route and one paved vehicular access route to each building shall be kept clean at all times. Other paving shall be cleaned when work in adjacent areas is completed.

B. Repairs: Any damage to existing landscape, paving, or other such features because of work related to this contract shall be repaired and restored to its original condition.

C. Protection: Protect landscape work and materials from damage due to landscape operations, operations by other Contractors, trades, and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged landscape work as directed.

END OF SECTION 329000
SECTION 329213

HYDRO-MULCHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including TPWD’s Uniform General Conditions, and Supplementary Conditions and Division 1 Specifications Sections, apply to this Section.

1.2 SUMMARY

A. Work includes, furnishing and applying hydromulch seeding, erosion control fabric, site clean up, and maintenance and guarantee.

B. Related Sections include the following:
   1. Section 312000 – Earth Moving
   2. Section 329000 – Trees, Shrubs and Groundcovers
   3. Section 329219 – Hydraulic Seeding

1.3 QUALITY ASSURANCE

A. Source:

   1. Seed: The Owner and Landscape Architect shall be furnished a signed copy of statement from vendor, certifying that each container of seed delivered is labeled in accordance with the Federal Seed Act and is at least equal to requirements previously specified. Seed analysis shall be furnished prior to commencement of planting operations. Each lot of seed may be resampled and retested in accordance with latest Rules and Regulations under the Federal Seed Act at the discretion of the Landscape Architect. If these tests reveal the seed to be below the specified pure live seed content, the Contractor shall be required to plant additional seed to compensate for the deficiency at no additional cost to the Owner. The seed retests will be conducted by the State Seed Laboratory. Allowance will be made for the actual pure live seed content of the specified grasses in determining the actual planting rate.

B. Inspections:

   1. Make written request for inspection after seeding operations have been completed. Such inspection is for the purpose of establishing the Maintenance Period.

   2. Submit written requests for inspections to the Engineer and Landscape Architect at least seven (7) days prior to anticipated inspection date.

1.4 SUBMITTALS

A. Furnish required copies of manufacturer's literature, certifications, or laboratory analytical data for the following items:

   1. Source. (Certification).
1.5 FINAL ACCEPTANCE

A. Work under this Section will be accepted by Landscape Architect upon satisfactory completion of all work, but exclusive of re-application under the Guarantee Period. Final Acceptance of lawn establishment shall be as follows:

1. For Seed: Ninety five (95%) percent uniform coverage of grass in excess of one (1") inch height. No bare spots of greater than two (2) square feet will be accepted.

2. The Landscape Architect and/or Owner shall interpret the above. Upon Final Acceptance, the Owner will assume the responsibility for maintenance of the work.

1.6 CLEAN UP

A. Keep all areas of work clean, neat, and orderly at all times. Keep all paved areas clean during lawn installation operations. Clean up and remove all deleterious materials and debris from the entire work area prior to Final Acceptance to the satisfaction of Landscape Architect.

PART 2 - PRODUCTS

2.1 SEED

A. All seed used shall be labeled in accordance with U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act. All seed shall be furnished in sealed standard containers unless exception is granted in writing by the Landscape Architect. Seed which has become wet, moldy, or otherwise damaged in transit or in storage will not be acceptable. The minimum percentage by weight of pure live seed in each lot of seed shall be as follows and seed shall be planted at the rate per acre indicated under pure live seed required per acre.

Hydromulching is ONLY for areas of Bermuda Grass establishment. The prescribed seed mix will vary depending upon the season during which revegetation is undertaken as shown below.
Minimum % Pure Live Seed Required Pounds Pure Per Acre

<table>
<thead>
<tr>
<th>Kind of Seed</th>
<th>% Pure</th>
<th>Pounds Pure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer Mix (April 15 to Sept 15):</td>
<td>85</td>
<td>65</td>
</tr>
<tr>
<td>Common Bermuda Grass- (Hulled) (Cynodon dactylon)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter Mix (September 15 to April 15):</td>
<td>85</td>
<td>65</td>
</tr>
<tr>
<td>Common Bermuda Grass- (Hulled) (Cynodon dactylon)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tall Fescue- Variety KY-31</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Weed seed shall not exceed ten (10%) percent by weight of the total of pure live seed and other material in the mixture. Johnson grass, nut grass, or other noxious weed seed will not be allowed.

Restrictions: Install Bermuda Hydromulch between April 15 and September 15, when average temperatures are between 75 to 85 degrees or higher for first 5 to 6 weeks.

2.2 FERTILIZER FOR TANK MIX

A. Shall be 13-13-13 grade, pelleted, uniform in composition, free-flowing, and suitable for application with approved equipment. The fertilizer shall be delivered to the site in bags or other convenient containers, each fully labeled, conforming to the applicable State fertilizer laws, and bearing the name or trademark and warranty of the producer.

2.3 FIBER MULCH

A. Fiber mulch, for use with the hydraulic application of grass seed and fertilizer, shall consist of specially prepared mulch. It shall be processed in such a manner that it will not contain germination or growth inhibiting factors. It shall be dyed an appropriate color to allow visual metering of its application. The mulch shall have the property of becoming evenly dispersed and suspended when agitated in water. When sprayed uniformly on the surface of the soil, the fibers shall form a blotter-like groundcover which readily absorbs water and allows infiltration to the underlying soil. Weight specifications from suppliers for all applications shall refer only to air dry weight of the fiber, a standard equivalent to eighteen (18%) percent moisture. The mulch material shall be supplied in packages having a gross weight not in excess of 100 pounds and be marked by the manufacturer to show the dry weight content. Suppliers shall be prepared to certify that laboratory and field testing of their product has been accomplished and that it meets all of the foregoing requirements.

2.4 WATER

A. Shall be free from oil, acid, alkali, salt, and other substances harmful to growth of grass. The water source shall be subject to approval by TPWD prior to use.

B. Contractor is responsible for providing temporary irrigation until turf is fully established.
2.5 SLURRY MIX COMPONENTS PER ACRE

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber Mulch</td>
<td>2,000 Pounds</td>
</tr>
<tr>
<td>Grass Seed</td>
<td>(As Specified)</td>
</tr>
<tr>
<td>Fertilizer (13-13-13)</td>
<td>800 Pounds</td>
</tr>
</tbody>
</table>

2.6 TOPDRESS FERTILIZER

A. (Delayed Application) Complete fertilizer, fifty (50%) percent of the nitrogen to be derived from natural organic sources or urea-form. Available phosphoric acid shall be from superphosphate, bone, or tankage. Potash shall be derived from muriate of potash containing sixty (60%) percent potash:

- 16% Nitrogen
- 6% Phosphoric Acid
- 8% Potash

2.7 TOPDRESS MIX:

- 1/3 Cubic Yard  Topsoil
- 2/3 Cubic Yard  Sand

2.8 2.8 EROSION CONTROL BLANKET

- Native American Seed Wood Fiber Erosion Control Blanket (without poly-nettings) with 6” U-shaped steel staples.

PART 3 - EXECUTION

3.1 HYDROMULCH SEEDING ON PREPARED FINISHED GRADE

A. Bed Preparation: Immediately after the finished grade has been approved, begin hydroseeding operation to reduce excessive weed growth.

B. Special Mulching Equipment and Procedures: Hydraulic equipment used for the application of fertilizer, seed, and slurry of prepared wood fiber mulch shall have a built-in agitation system with an operating capacity sufficient to agitate, suspend, and homogeneously mix a slurry containing up to forty (40) pounds of fiber plus a combined total of seventy (70) pounds of fertilizer solids for each one hundred (100) gallons of water. The slurry distribution lines shall be large enough to prevent stoppage. The discharge line shall be equipped with a set of hydraulic spray nozzles which provide even distribution of the slurry on the slopes to be seeded. The slurry tank shall have a minimum capacity of eight hundred (800) gallons and shall be mounted on a traveling unit which may be either self-propelled or drawn with a separate unit which will place the slurry tank and spray nozzles within sufficient proximity to the areas to be seeded so as to provide uniform distribution without waste. The Landscape Architect may authorize equipment with smaller tank capacity provided that the equipment has the necessary agitation system and sufficient pump capacity to spray the slurry in a uniform coat.
C. Mixing: Care shall be taken that the slurry preparation takes place on the site of the work. The slurry preparation should begin by adding water to the tank when the engine is at half throttle. When the water level has reached the height of the agitator shaft, good recirculation shall be established and seed shall be added. Fertilizer shall then be added, followed by wood pulp mulch. The wood pulp mulch shall only be added to the mixture after the seed and when the tank is at least one-third filled with water. The engine throttle shall be opened to full speed when the tank is half filled with water. All the wood pulp mulch shall be added by the time the tank is two-thirds to three-fourths full. Spraying shall commence immediately when the tank is full. The operator shall spry the area with a uniform, visible coat by using the green color of the wood pulp as a guide.

D. Application:

1. Contractor shall obtain approval of hydromulch area preparation from the owner prior to application.

2. Operators of hydromulching equipment shall be thoroughly experienced in this type of application. Apply specified slurry mix in a motion to form a uniform mat at specified rate.

3. Keep hydromulch within areas designated and keep from contact with other plant material.

4. Slurry mixture which has not been applied within four (4) hours of mixing shall not be used and shall be removed from the site.

5. After application, the Contractor shall not operate any equipment over the covered area.

6. Immediately after application, thoroughly wash off any plant material, planting areas, or paved areas not intended to receive slurry mix. Keep all paved and planting areas clean during maintenance operations.

7. Cover all slopes 4:1 or steeper with Native American Seed Wood Fiber Erosion Control Blanket (without poly-nettings) anchored with 6” U-shaped steel staples according to manufacturer’s instructions.

8. Refer also to the maintenance portion of this Section.

E. Unseeded Areas: If, in the opinion of the Landscape Architect, unplanted skips and areas are noted after hydromulching, the Contractor shall be required to seed the unplanted areas with the grasses that were to have been planted at no additional cost to the Owner.

3.2 INSPECTIONS

A. Make written request for inspection prior to seeding and after areas have been seeded and sodded.

B. Submit requests for inspections to Landscape Architect at least two (2) days prior to anticipated inspection date.
PART 1 - GENERAL

1.1 SUMMARY

A. Work includes furnishing and applying hydraulic seeding of native Texas grasses and wildflowers, site clean up, maintenance and guarantee.

B. Related Sections include the following:
   1. Section 329000 – Tree, Shrub and Groundcover planting
   2. Section 329213 - Hydromulching

1.2 QUALITY ASSURANCE

A. Source:
   1. Seed: The Landscape Architect shall be furnished a signed copy of statement from vendor, certifying that each container of seed delivered is labeled in accordance with the Federal Seed Act and is at least equal to requirements previously specified. Seed analysis shall be furnished prior to commencement of planting operations. Each lot of seed may be resampled and retested in accordance with latest Rules and Regulations under the Federal Seed Act at the discretion of the Landscape Architect. If these tests reveal the seed to be below the specified pure live seed content, the Contractor shall be required to plant additional seed to compensate for the deficiency at no additional cost to the Owner. The seed retests will be conducted by the State Seed Laboratory. Allowance will be made for the actual pure live seed content of the specified grasses in determining the actual planting rate.

B. Inspections:
   1. Make written request for inspection after seeding operations have been completed. Such inspection is for the purpose of establishing the Maintenance Period.
   2. Submit written requests for inspections to the Landscape Architect at least seven (7) days prior to anticipated inspection date.

1.3 SUBMITTALS

Furnish required copies of manufacturer's literature, certifications, or laboratory analytical data for the following items:

   1. Source. (Certification).
   2. Fiber Mulch. (Laboratory Analytical Data).
1.4 FINAL ACCEPTANCE

Work under this Section will be accepted by Landscape Architect upon satisfactory completion of all work, but exclusive of re-application under the Guarantee Period. Final Acceptance of lawn establishment shall be as follows:

For Seed: Coverage areas must meet or exceed eighty five (85%) percent native species of grasses and forbs after 3 years. No bare spots of greater than two (2) square feet will be accepted.

The Landscape Architect and/or Owner shall interpret the above. Upon Final Acceptance, the Owner will assume the responsibility for maintenance of the work.

1.5 CLEAN UP

Keep all areas of work clean, neat, and orderly at all times. Keep all paved areas clean during lawn installation operations. Clean up and remove all deleterious materials and debris from the entire work area prior to Final Acceptance.

PART 2 - PRODUCTS

2.1 SEED

A. All seed used shall be labeled in accordance with U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act. All seed shall be furnished in sealed standard containers unless exception is granted in writing by the Landscape Architect. Seed which has become wet, moldy, or otherwise damaged in transit or in storage will not be acceptable.

Seed mixes shall be provided from Native American Seed or approved equal.

Contact Information:
Native American Seed
3791 N US Hwy 377
Junction, TX 76849
800.728.4043
www.seedsource.com

The minimum percentage by weight of pure live seed in each lot of seed shall be as follows and seed shall be planted at the rate per acre indicated under pure live seed required per acre.
B. Seed Mixes

Native Seed- Sun Mix
Blackland Prairie Mix – 20 lbs / Acre, containing Buffalograss 14.53%, Little Bluestem 9.22%,
Indian Blanket 6.45%, Eastern Gamagrass 4.97%, Sideoats Grama 4.96%, Indiangrass 4.96%,
Illinois Bundleflower 4.96%, Big Bluestem 4.51%, Virginia Wildrye 3.76%, Texas Yellow Star 3.75%,
Plains Bristlegrass 3.55%, American Basketflower 3.51%, Prairie Wildrye 3.51%, Texas Cupgrass
3.01%, Purple Prairie Clover 3.01%, Green Sprangletop 2.56%, Cutleaf Daisy 2.00%, Maximilian
Sunflower 2.00%, Partridge Pea 1.81, Annual Winecup 1.50%, Switchgrass 1.45%, Lemon Mint
1.12%, Purpletop 1.00%, Plains Coreopsis 1.00%, Sand Lovegrass 0.98%, Standing Cypress
0.95%, Black Eyed Susan 0.92%, Clasping Coneflower 0.69%, Hooded Windmill Grass 0.58%,
White Tridens 0.51%, Inland Sea oats 0.45%, Broomsedge Bristlegrass 0.45%, Sand Dropseed
0.40%, Prairie Agalinis 0.32%, Mealy Blue Sage 0.15%, Butterfly Weed 0.14%, Common
Milkweed 0.10%, Canada Goldenrod 0.05%, Winecup 0.045%, Rose Milkweed 0.04%,
Rattlesnake Master 0.03%, Prairie Verbena 0.025%, Foxglove 0.017%, White Rosinweed
0.011%, Showy Milkweed 0.010%, Florida Paspalum 0.007%, Spiderwort 0.003%, Cane
Bristlegrass 0.001%

Native Seed- Shade Mix:
Shade Friendly Grass Mix – 20 lbs / Acre, Eastern Gamagrass 27.04%, Prairie Wildrye 22.7%,
Sideoats Grama 20%, Virginia Wildrye 12.52%, Purpletop 6.98%, White Tridens 3%, Texas
Wintergrass 2.75%, Plains Bristlegrass 1.75%

Native Short Grass Mix:
Thunderturf – 3 lbs / 1000 Sf, containing 82% Buffalograss, 17% Blue Grama, 1% Curly Mesquite

Shoreline Mix:
Riparian Recovery Mix – 9 lbs / Acre, containing Eastern Gamagrass 13.68%, Illinois Bundleflower
10.00%, Prairie Wildrye 9.77%, Indiangrass 8.77%, Virginia Wildrye 8.73%, Sideoats Grama 8.08%,
Plains Bristlegrass 4.99%, Inland Sea oats 4.99%, Maximilian Sunflower 4.77%, Big Bluestem
4.57%, Switchgrass 3.51%, Partridge Pea 2.93%, Scarlet Sage 2.85%, Green Sprangletop 1.89%,
Plains Coreopsis 1.62%, Clasping Coneflower 1.48%, Lemon Mint 1.32%, Texas Cupgrass 1.24%,
Florida Paspalum 1.00%, Marsh Elder 1.00% Sand Dropseed 0.76%, Frostweed 0.53%, Black Eyed
Susan 0.47%, Alkali Sacaton 0.27%, Canada Goldenrod 0.22%, Sawgrass 0.21%, Cane Bristlegrass
0.10%, White Tridens 0.10%, Rose Milkweed 0.05%, Cardinal Flower 0.05%, Swamp Sunflower
0.05%

Winter Seeding:
If planting occurs between September & February, all native seeding zones shall
also receive: Cereal Rye Grain (Secale cereale) – 100 lbs / Acre. All areas
planted with Cereal Rye Grain must be mowed before seed heads ripen.

Weed seed shall not exceed ten (10%) percent by weight of the total of pure live seed and other
material in the mixture. Johnson grass, nut grass, or other noxious weed seed will not be allowed.

C. Seed Mix Locations & Limits

Hatches on the planting plans delineating boundaries of seed mixes are conceptual in nature.
contractor is responsible for revegetating all soil disturbed by construction activity.

Bermuda seed shall not be applied within any areas delineated as “No Mow” areas on the plans.
Reference 329213 Hydromulching for Bermuda grass installation. Areas labeled as “No Mow”
may be revegetated as indicated by hatch boundaries or according to applications as shown
below:
Shoreline Mix:
- No Mow Areas
- Disturbed areas directly above the Normal Pool 522 elevation.
- Disturbed areas within and adjacent to existing wetlands

Native Seed Sun Mix:
- No Mow Areas
- Disturbed sunny areas upslope from the shoreline

Native Seed Shade Mix:
- No Mow Areas
- Disturbed areas that will receive less than 6 hours of direct sunlight
- Not to be applied in areas that receive significant western sun exposure.

Native Short Grass Mix:
- Both No Mow and Mowed Areas
- Areas above proposed gabion walls as shown on Plan Sheet L103.
- Disturbed areas on Plan Sheet L106 between the Shoreline mix and “No Mow” limits and the proposed trail.
- Disturbed areas to be mowed surrounding the Group Recreation Hall and parking lot as delineated by Plan Sheet L108.

2.2 FIBER MULCH: Fiber mulch, for use with the hydraulic application of grass seed, shall consist of specially prepared mulch. It shall be processed in such a manner that it will not contain germination or growth inhibiting factors. It shall be dyed an appropriate color to allow visual metering of its application. The mulch shall have the property of becoming evenly dispersed and suspended when agitated in water. When sprayed uniformly on the surface of the soil, the fibers shall form a blotter-like groundcover which readily absorbs water and allows infiltration to the underlying soil. Weight specifications from suppliers for all applications shall refer only to air dry weight of the fiber, a standard equivalent to eighteen (18%) percent moisture. The mulch material shall be supplied in packages having a gross weight not in excess of 100 pounds and be marked by the manufacturer to show the dry weight content. Suppliers shall be prepared to certify that laboratory and field testing of their product has been accomplished and that it meets all of the foregoing requirements.

2.3 WATER: Shall be free from oil, acid, alkali, salt, and other substances harmful to growth of grass. The water source shall be subject to approval prior to use. Contractor is responsible for providing temporary irrigation until turf is fully established.
SLURRY MIX COMPONENTS PER ACRE

Fiber Mulch  Minimal. For marking only
Native Seed  (As Specified)

2.4 TOPDRESS MIX:

Native Topsoil

2.5 EROSION CONTROL BLANKET

Native American Seed Wood Fiber Erosion Control Blanket (without poly-nettings) with 6” U-shaped steel staples.

PART 3 - EXECUTION

3.1 HYDRAULIC SEEDING ON PREPARED FINISHED GRADE

A. Bed Preparation: Immediately after the finished grade has been approved, begin hydraulic seeding operation to reduce excessive weed growth.

B. Special Mulching Equipment and Procedures: Hydraulic equipment used for the application of fertilizer, seed, and slurry of prepared wood fiber mulch shall have a built-in agitation system with an operating capacity sufficient to agitate, suspend, and homogeneously mix a slurry containing up to forty (40) pounds of fiber plus appropriate gallons of water. The slurry distribution lines shall be large enough to prevent stoppage. The discharge line shall be equipped with a set of hydraulic spray nozzles which provide even distribution of the slurry on the slopes to be seeded. The slurry tank shall have a minimum capacity of eight hundred (800) gallons and shall be mounted on a traveling unit which may be either self-propelled or drawn with a separate unit which will place the slurry tank and spray nozzles within sufficient proximity to the areas to be seeded so as to provide uniform distribution without waste. The Landscape Architect may authorize equipment with smaller tank capacity provided that the equipment has the necessary agitation system and sufficient pump capacity to spray the slurry in a uniform coat.

C. Mixing: Care shall be taken that the slurry preparation takes place on the site of the work. The slurry preparation should begin by adding water to the tank when the engine is at half throttle. When the water level has reached the height of the agitator shaft, good recirculation shall be established and seed shall be added, followed by wood pulp mulch. The wood pulp mulch shall only be added to the mixture after the seed and when the tank is at least one-third filled with water. The engine throttle shall be opened to full speed when the tank is half filled with water. All the wood pulp mulch shall be added by the time the tank is two-thirds to three-fourths full. Spraying shall commence immediately when the tank is full. The operator shall spry the area with a uniform, visible coat by using the green color of the wood pulp as a guide.
D. Application:

1. Contractor shall obtain approval of hydroseed area preparation form the Landscape Architect prior to application.

2. Operators of hydroseed equipment shall be thoroughly experienced in this type of application. Apply specified slurry mix in a motion to form a uniform mat at specified rate.

3. Keep hydroseed within areas designated and keep from contact with other plant material.

4. Native seed needs to contact soil directly for successful germination. Use only enough fiber to mark spray pattern.

5. Slurry mixture which has not been applied within four (4) hours of mixing shall not be used and shall be removed from the site.

6. Native seeds must be covered with no more than 3/8” depth of fiber material to achieve successful germination.

7. After application, the Contractor shall not operate any equipment over the covered area.

8. Immediately after application, thoroughly wash off any plant material, planting areas, or paved areas not intended to receive slurry mix. Keep all paved and planting areas clean during maintenance operations.

9. Cover all slopes 4:1 or steeper with Native American Seed Wood Fiber Erosion Control Blanket (without poly-nettings) anchored with 6” U-shaped steel staples according to manufacturer’s instructions.

10. Refer also to the maintenance portion of this Section.

E. Unseeded Areas: If, in the opinion of the Landscape Architect, unplanted skips and areas are noted after hydroseed, the Contractor shall be required to seed the unplanted areas with the seed mixes that were to have been planted at no additional cost to the Owner. Contractor is also responsible for hydroseeding any areas disturbed during the construction process, even if they are outside the areas designated to receive seed.

3.2 INSPECTIONS

A. Make written request for inspection prior to seeding and after areas have been seeded and sodded.

B. Submit requests for inspections to Texas Parks and Wildlife (TPWD) at least two (2) days prior to the anticipated inspection date.

END OF SECTION 329219
SECTION 330500
COMMON WORK RESULTS FOR UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Piping joining materials.
2. Transition fittings.
3. Dielectric fittings.
4. Sleeves.
5. Identification devices.
7. Flowable fill.
8. Piped utility demolition.
9. Piping system common requirements.
10. Equipment installation common requirements.
11. Painting.
12. Concrete bases.
13. Metal supports and anchorages.

1.3 DEFINITIONS

A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.

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


D. CPVC: Chlorinated polyvinyl chloride plastic.

E. PE: Polyethylene plastic.

F. PVC: Polyvinyl chloride plastic.
1.4 ACTION SUBMITTALS
   A. Product Data: For the following:
      1. Dielectric fittings.
      2. Identification devices.

1.5 INFORMATIONAL SUBMITTALS
   A. Welding certificates.

1.6 QUALITY ASSURANCE
   A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   B. Steel Piping Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
      1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
      2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
   C. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.7 DELIVERY, STORAGE, AND HANDLING
   A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
   B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.8 COORDINATION
   A. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
   B. Coordinate installation of identifying devices after completing covering and painting if devices are applied to surfaces.
   C. Coordinate size and location of concrete bases. Formwork, reinforcement, and concrete requirements are specified in Section 033000 Cast-in-Place Concrete.
PART 2 - PRODUCTS

2.1 PIPING JOINING MATERIALS

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

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness, unless otherwise indicated.
   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

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

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

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

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

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


G. Solvent Cements for Joining Plastic Piping:

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

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

2.2 TRANSITION FITTINGS

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

B. Transition Couplings NPS 1-1/2 and Smaller:

1. Underground Piping: Manufactured piping coupling or specified piping system fitting.
2. Aboveground Piping: Specified piping system fitting.
C. AWWA Transition Couplings NPS 2 and Larger:

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

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

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

3. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.

D. Plastic-to-Metal Transition Fittings:

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

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

   a. Spears Manufacturing Co.

3. Description: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

E. Plastic-to-Metal Transition Unions:

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

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

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

3. Description: MSS SP-107, PVC four-part union. Include brass or stainless-steel threaded end, solvent-cement-joint plastic end, rubber O-ring, and union nut.

F. Flexible Transition Couplings for Underground Nonpressure Drainage Piping:

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

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Description: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.3 DIELECTRIC FITTINGS

A. Dielectric Fittings, General: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Industries, LLC; Wilkins; or comparable product by one of the following:

   a. Capitol Manufacturing Co.
   b. Central Plastics Company.
   c. Epco Sales, Inc.
   e. Watts Water Technologies, Inc.

2. Description: Factory fabricated, union, NPS 2 and smaller.

   a. Pressure Rating: 250 psig at 180 deg F.
   b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded ferrous.

C. Dielectric Flanges:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Industries, LLC; Wilkins; Model DUXLC (Lead-Free) or comparable product by one of the following:

   a. Capitol Manufacturing Co.
   b. Central Plastics Company.
   c. Epco Sales, Inc.
   d. Watts Regulator Co., a division of Watts Water Technologies, Inc.

2. Description: Factory-fabricated, bolted, companion-flange assembly, NPS 2-1/2 to NPS 3 and larger.

   a. Pressure Rating: 175 psig minimum.
   b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

2. Description: Nonconducting materials for field assembly of companion flanges, NPS 2-1/2 and larger.

   a. Pressure Rating: 150 psig minimum.
   b. Gasket: Neoprene or phenolic.
   c. Bolt Sleeves: Phenolic or polyethylene.
   d. Washers: Phenolic with steel backing washers.

E. Dielectric Couplings:

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

      a. Calpico, Inc.
      b. Lochinvar Corporation.

   3. Description: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining, NPS 3 and smaller.

      a. Pressure Rating: 300 psig at 225 deg F.
      b. End Connections: Threaded.

F. Dielectric Nipples:

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

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

      a. Perfection Corporation.
      b. Precision Plumbing Products, Inc.
      c. Victaulic Company.

   3. Description: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining.

      a. Pressure Rating: 300 psig at 225 deg F.
      b. End Connections: Threaded or grooved.
2.4 SLEEVES

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

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

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

D. Molded PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.

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

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

2.5 IDENTIFICATION DEVICES

A. General: Products specified are for applications referenced in other utilities Sections. If more than single type is specified for listed applications, selection is Installer's option.

B. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.
   1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
   2. Location: Accessible and visible.

C. Snap-on Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap-on type. Include color-coding according to ASME A13.1, unless otherwise indicated.

D. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive-vinyl type with permanent adhesive.

E. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe at each location.

F. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers, at least three times letter height and of length required for label.

G. Lettering: Manufacturer's standard preprinted captions as selected by Architect.

H. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
   1. Arrows: Either integrally with piping system service lettering to accommodate both directions of flow, or as separate unit on each pipe marker to indicate direction of flow.

I. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least 3 mils thick.
1. Width: 1-1/2 inches on pipes with OD, including insulation, less than 6 inches; 2-1/2 inches for larger pipes.
2. Color: Comply with ASME A13.1, unless otherwise indicated.

J. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Include 5/32-inch hole for fastener.

1. Material: 0.032-inch thick, polished brass
2. Material: 0.0375-inch thick stainless steel.
3. Material: 3/32-inch thick plastic laminate with 2 black surfaces and a white inner layer.
5. Size: 1-1/2 inches in diameter, unless otherwise indicated.
6. Shape: As indicated for each piping system.

K. Valve Tag Fasteners: Brass, wire-link or beaded chain; or brass S-hooks.

L. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Engraving: Engraver's standard letter style, of sizes and with terms to match equipment identification.
2. Thickness: [1/16 inch (1.6 mm)] [1/8 inch (3 mm)], unless otherwise indicated.
3. Thickness: 1/16 inch, for units up to 20 sq. in. or 8 inches in length, and 1/8 inch for larger units.
4. Fasteners: Self-tapping, stainless-steel screws or contact-type permanent adhesive.

M. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in the following color codes:

1. Green: Cooling equipment and components.
2. Yellow: Heating equipment and components.
4. Blue: Equipment and components that do not meet criteria above.
6. Terminology: Match schedules as closely as possible. Include the following:
   a. Name and plan number.
   b. Equipment service.
   c. Design capacity.
   d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

7. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

N. Plasticized Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with mat finish suitable for writing.

1. Size: 3-1/4 by 5-5/8 inches.
2. Fasteners: Brass grommets and wire.
3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.

O. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in piped utility identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of piped utility systems and equipment.

1. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

2.6 GROUT

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

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

2.7 FLOWABLE FILL

A. Description: Low-strength-concrete, flowable-slurry mix.

3. Aggregates: ASTM C 33, natural sand, fine and crushed gravel or stone, coarse.
6. Water: Comply with ASTM C 94/C 94M.
7. Strength: 100 to 200 psig at 28 days.

PART 3 - EXECUTION

3.1 PIPED UTILITY DEMOLITION

A. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.

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

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

3.2 DIELECTRIC FITTING APPLICATIONS

A. Dry Piping Systems: Connect piping of dissimilar metals with the following:
   1. NPS 2 and Smaller: Dielectric unions.
   2. NPS 2-1/2 to NPS 12: Dielectric flanges.

B. Wet Piping Systems: Connect piping of dissimilar metals with the following:
   1. NPS 2 (DN 50) and Smaller: Dielectric couplings.
   2. NPS 2-1/2 to NPS 4: Dielectric nipples.
   3. NPS 2-1/2 to NPS 8: Dielectric nipple.
   4. NPS 10 and NPS 12: Dielectric flange kits.

3.3 PIPING INSTALLATION

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

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

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 to permit valve servicing.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

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

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

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

J. Permanent sleeves are not required for holes formed by removable PE sleeves.
K. Verify final equipment locations for roughing-in.

L. Refer to equipment specifications in other Sections for roughing-in requirements.

3.4 PIPING JOINT CONSTRUCTION

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

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

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

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.


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

G. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

H. Soldered Joints: Apply ASTM B 813 water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.


J. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.

K. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
   3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.

5. PVC Nonpressure Piping: Join according to ASTM D 2855.

6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

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

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

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

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

O. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer’s written instructions.

3.5 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Install dielectric fittings at connections of dissimilar metal pipes.

3.6 EQUIPMENT INSTALLATION

A. Install equipment level and plumb, unless otherwise indicated.

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

C. Install equipment to allow right of way to piping systems installed at required slope.

3.7 PAINTING

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

3.8 IDENTIFICATION

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.
2. Plastic markers, with application systems. Install on insulation segment if required for hot noninsulated piping.
3. Locate pipe markers on exposed piping according to the following:
   a. Near each valve and control device.
   b. Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.
   c. Near locations where pipes pass through walls or floors or enter inaccessible enclosures.
   d. At manholes and similar access points that permit view of concealed piping.
   e. Near major equipment items and other points of origination and termination.

B. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.
   1. Lettering Size: Minimum 1/4 inch high for name of unit if viewing distance is less than 24 inches, 1/2 inch high for distances up to 72 inches, and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
   2. Text of Signs: Provide name of identified unit. Include text to distinguish among multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

C. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGES
A. Refer to Section 055013 "Metal Fabrications" for structural steel.
B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor piped utility materials and equipment.
C. Field Welding: Comply with AWS D1.1/D1.1M.

3.10 GROUTING
A. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.
B. Clean surfaces that will come into contact with grout.
C. Provide forms as required for placement of grout.
D. Avoid air entrapment during placement of grout.
E. Place grout, completely filling equipment bases.
F. Place grout on concrete bases and provide smooth bearing surface for equipment.
G. Place grout around anchors.
H. Cure placed grout.

END OF SECTION 330500
SECTION 330510
DECHLORINATION ACTIVITIES

PART 1  GENERAL

1.1  SUMMARY

This Section includes furnishing and performing of all operations in connection with dechlorination of waters released from water lines, water receiving facilities, and groundwater treatment plants.

1.2  MEASUREMENT AND PAYMENT

A. No separate payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

1.3  REFERENCES

This specification references the following publications in their current editions. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

A. AWWA C651: Standard for Disinfecting Water Mains
B. AWWA C655: Standard for Field Dechlorination
C. National Sanitation Foundation International (NSF)
D. NSF/ANSI 61: Standards for Drinking Water Systems Components
E. Texas Commission on Environmental Quality (TCEQ)

1. 30 TAC 290 Subchapter D: Rules and Regulations for Public Water Systems
2. 30 TAC Chapter 290 Subchapter F: Drinking Water Standards Governing Drinking Water Quality and Reporting Requirements for Public Water Systems

1.4  SUBMITTALS

A. Dechlorination Plan:

Contractor shall submit a plan detailing the methods and equipment to be used in the addition of dechlorination chemicals to points where discharge of chlorinated water occurs, when needed based on chlorine residuals. This plan shall contain the following information:

1. Methods of adding dechlorination chemicals at points where discharge of chlorinated water occurs. These locations shall be identified in the dechlorination plan. The methodology listed in the plan will include the
following:

a. Expected water flow at each discharge location where application of dechlorination chemicals is anticipated.

b. Expected quantity, form and type of chemicals needed at each location

c. Equipment necessary for application of chemicals at each location

2. Methods of testing for free chlorine residual at each of the locations (See paragraph 3.01.E) and meeting the requirements of AWWA 651, AWWA 655, and TCEQ guidelines (30 TAC 290 Subchapter D and 30 TAC Chapter 290 Subchapter F).

3. Frequency of sampling activities to ensure proper dechlorination and precautions to prevent overuse of chemicals

4. Technical data for equipment to be used during the addition of dechlorination chemicals

1.5 RELATED REQUIREMENTS

1. Section 221113 Facility Water Distribution Piping
2. Section 330500 Common Work Results for Utilities
3. Section 334105 High Density Polyethylene Pipe

1.6 QUALITY ASSURANCE

A. Singular Responsibility:

1. The Contractor is responsible for developing the approach, designing the dechlorination systems, selecting equipment, implementing the approach, monitoring the activity, and all other services and equipment necessary to perform the work and accomplish the stated goals.

2. The Contractor is responsible for dechlorinating the water released during cleaning and flushing, disinfection, hydrostatic testing, and start-up operations.

1.7 – 1.13 NOT USED

PART 2 PRODUCTS

2.1 MANUFACTURER(S) (NOT USED)

2.2 MATERIALS

Materials and equipment used in the dechlorination activities shall comply with the requirements of NSF/ANSI 61, AWWA 651, AWWA 655, and all other county, state and federal regulations for potable water systems, as applicable. If the material does not meet the chemical, physical, safety, or security requirements of these standards, the Contractor will be notified promptly after observing the noncompliance, and all activities will cease until compliance is achieved.
2.3 METHODS FOR TESTING FOR CHLORINE RESIDUAL

A. Methods used for field testing of free chlorine residual shall meet the minimum requirements of AWWA C651 and C655. The following methods meet these standards and are acceptable to the Owner:

1. Test Strips with a resolution sufficient to determine residual concentration at the specified limit:

2. Orthotolidine Indicator Kit

3. Field Colorimetric Test Kits

4. DPD Titration Method

B. The initial chlorine residual test will be taken at a location before the water is discharged from the piping and before the point where dechlorination chemicals are added.

C. The second chlorine residual test taken to verify the dechlorination effort will be taken at a distance away from the injection point that accounts for a detention time of 20 seconds for the given flow and pipe/swale size.

2.4 DECHLORINATION METHODS/EQUIPMENT

A. Dechlorination will occur at all locations where water is being released and discharged into the storm water drainage systems.

B. While dechlorination chemicals are present at a location, the Contractor will have someone on-site to guarantee security of the equipment and chemicals.

C. Equipment chosen by the Contractor must be adequate to meet the varying conditions experienced during the start-up and commissioning, due the variances in flow, chlorine residuals, methods of application, and locations where equipment is to be used.

D. The four general methods of dechlorination approved by AWWA C655 are:

1. Vacuum-induced (chemicals are drawn directly into the flow by means of a vacuum). These devices must be provided with a means to monitor and control the amount of dechlorination solution entering the main flow of discharge water.

2. Passive devices that require the flow of water to make direct contact with the dechlorination chemical. This type of device normally uses some type of dry or tablet dechlorination chemical.

3. Devices that drip dechlorination chemicals into the discharge water flow. These devices must be provided with a means to monitor and control the amount of dechlorination solution entering the main flow of discharge water.

4. Injection pumps used to add dechlorination chemicals into the main flow of discharge water. Contractor is responsible for supplying the source of power for operating the pumps.
E. Manufactured Equipment

When using manufactured equipment, the Contractor must use the dechlorination tables provided by the manufacturer of the equipment to determine what chemicals should be used and the required amount of dechlorination chemical.

F. User-Built Equipment

If the Contractor is using equipment they have developed or produced, the Contractor shall provide certification that this equipment meets the requirements of this Section and all applicable standards. In lieu or certification, the equipment can be field tested before actual use.

PART 3 EXECUTION

3.1 DECHLORINATION DURING DISINFECTION, FLUSHING, START-UP OPERATIONS AND REPAIRS

A. Prior to work beginning, a preliminary meeting will be held with the Project Manager to discuss various items relating to dechlorination activity.

B. The Contractor shall discharge highly chlorinated water and fill with water having a chlorine residual that is less than 4.0 mg/l.

C. Locations where water is discharged:

1. Along with the identification of where the water will be released, the Contractor shall log and provide the following information for each location:

   a. Discharge flow rate (gpm)
   b. Quantity of water released (gallons)
   c. Duration of release (hours)
   d. Discharge pressure (psi)

D. The Owner may choose to phase the work and sequentially discharge water from one or more locations over a longer period of time.

E. Flushing and dechlorination activities may occur for 16 hours per day when directed by the Owner.

F. To meet the dechlorination needs for these activities, the Contractor will be responsible for the following at each discharge location:

   1. Mobilizing dechlorination equipment sized to handle the anticipated flows and residuals,
   2. Providing sufficient quantities of dechlorination chemicals to dechlorinate waters released to the storm water system,
   3. Providing sufficient manpower to operate all dechlorination equipment and perform chlorine residual testing of waters released from the system, and
4. Testing the free chlorine residuals of all water flushed using the methods covered in paragraph 2.03 of this Section.
   
a. Testing will occur, at a minimum, every one-half hour while waters are being released. The Contractor shall increase sampling times as necessary to ensure that all water is dechlorinated sufficiently.
   
b. Testing will occur at the point of release and at the point where a twenty (20) second detention time has occurred.

G. Dechlorination of flushed water will meet the following requirements.
   
1. All water discharging with a residual greater than 0.5 mg/L must be dechlorinated by the Contractor until the maximum chlorine residual concentration is reduced to less than 0.5 mg/L but greater than 0.1 mg/L. Dechlorination of water discharged from the WDSS must be continued until the flow is stopped or chlorine levels in the discharged water drop below 0.5 mg/L and above 0.1 mg/L.

2. When directed by the Owner, Contractor will be responsible for removing all dechlorination equipment and chemicals from the site.

3.2 – 3.10 NOT USED

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Nonpressure transition couplings.
3. Pressure pipe couplings.
4. Expansion joints and deflection fittings.
5. Backwater valves.
6. Cleanouts.
7. Drains.
8. Encasement for piping.
10. Channel drainage systems.
11. Catch basins.
13. Stormwater detention structures.
15. Dry wells.
16. Stormwater disposal systems.

1.2 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. PVC Cellular-Core Piping:

1. PVC Cellular-Core Pipe and Fittings: ASTM F 891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.

B. PVC Corrugated Sewer Piping:

2. Fittings: ASTM F 949, PVC molded or fabricated, socket type.

C. PVC Profile Sewer Piping:
   2. Fittings: ASTM D 3034, PVC with bell ends.

D. PVC Type PSM Sewer Piping:
   1. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
   2. Fittings: ASTM D 3034, PVC with bell ends.

E. PVC Gravity Sewer Piping:

2.2 CLEANOUTS

A. Cast-Iron Cleanouts:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Specification Drainage Operation; Zurn Plumbing Products Group; or comparable product by one of the following:
      b. MIFAB, Inc.
      d. Tyler Pipe.
      e. Watts Water Technologies, Inc.
   2. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
   3. Top-Loading Classification(s): Heavy Duty.
   4. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.
B. Plastic Cleanouts:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Light Commercial Products Operation; Zurn Plumbing Products Group; or comparable product by one of the following:
   a. Canplas LLC.
   b. IPS Corporation.
   c. NDS Inc.
   d. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
   e. Sioux Chief Manufacturing Company, Inc.

2. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

PART 3 - EXECUTION

3.1 EARTHWORK

   A. Excavation, trenching, and backfilling are specified in Section 312000 “Earth Moving.”

3.2 PIPING INSTALLATION

   A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

   B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

   C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

   D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

   E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

   F. Install gravity-flow, nonpressure drainage piping according to the following:

      1. Install piping pitched down in direction of flow as indicated on drawings.
      2. Install PVC cellular-core piping according to ASTM D 2321 and ASTM F 1668.
      3. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
      4. Install PVC profile gravity sewer piping according to ASTM D 2321 and ASTM F 1668.
3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:
   1. Join PVC cellular-core piping according to ASTM D 2321 and ASTM F 891 for solvent-
      cemented joints.
   2. Join PVC corrugated sewer piping according to ASTM D 2321 for elastomeric-seal joints.
   3. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-
      seal joints or ASTM D 3034 for elastomeric-gasketed joints.
   4. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal
      joints or ASTM F 794 for gasketed joints.

3.4 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred.
   Inspect after approximately 12 inches of backfill is in place, and again at completion of Project.

   1. Submit separate reports for each system inspection.
   2. Defects requiring correction include the following:

      a. Alignment: Less than full diameter of inside of pipe is visible between structures.
      b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder
         of size not less than 92.5 percent of piping diameter.
      c. Damage: Crushed, broken, cracked, or otherwise damaged piping.

   3. Reinspect and repeat procedure until results are satisfactory.

3.5 CLEANING

A. Clean interior of piping of dirt and superfluous materials.

END OF SECTION 334100
PART 1 – GENERAL

1.1 DESCRIPTION

A. SCOPE

1. This section specifies high density polyethylene (HDPE) pipe and fittings, including acceptable fusion technique and practice, and safe handling and storage.

B. PIPE DESCRIPTION

1. Pipe Supplier shall furnish high density polyethylene (HDPE) pipe and fittings conforming to all applicable standards and procedures as referenced in this specification, and meeting all applicable testing and material properties as described by the applicable standards referenced in this specification or as required within this specification. All pipe shall be compatible with Ductile Iron Pipe Size fittings and be DR11 pipe.

1.2 QUALITY ASSURANCE

A. REFERENCES:

1. This section contains references to the following documents. They are a part of this section to the extent referenced in this specification. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of a conflict between the requirements of this section and those of the referenced documents, the requirements of this specification shall prevail.

2. Unless otherwise specified, references to documents shall mean the latest published edition of the referenced document in effect at the time of construction.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Title</th>
</tr>
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<tbody>
<tr>
<td>AWWA C651</td>
<td>Standard for Disinfecting Water Mains</td>
</tr>
<tr>
<td>ANSI/AWWA C901</td>
<td>Polyethylene (PE) Pressure Pipe and Tubing, ¾ In. (17 mm) Through 3 In. (76 mm) for Water Service</td>
</tr>
<tr>
<td>ANSI/WWA C906</td>
<td>Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,600 mm), for Water Distribution and Transmission</td>
</tr>
<tr>
<td>ASTM C923</td>
<td>Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals</td>
</tr>
<tr>
<td>ASTM D1603</td>
<td>Standard Test Method for Carbon Black in Olefin Plastics</td>
</tr>
<tr>
<td>ASTM D2321</td>
<td>Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications</td>
</tr>
<tr>
<td>ASTM D2774</td>
<td>Standard Practice for Underground Installation of Thermoplastic Pressure Piping</td>
</tr>
<tr>
<td>ASTM D3035</td>
<td>Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter</td>
</tr>
<tr>
<td>ASTM D3350</td>
<td>Standard Specification for Polyethylene Plastics Pipe and Fittings Materials</td>
</tr>
<tr>
<td>ASTM D4218</td>
<td>Standard Test method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique</td>
</tr>
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<td>Reference</td>
<td>Title</td>
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</tr>
<tr>
<td>ASTM F585</td>
<td>Standard Practice for Insertion of Flexible Polyethylene Pipe Into Existing Sewers</td>
</tr>
<tr>
<td>ASTM F714</td>
<td>Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter</td>
</tr>
<tr>
<td>ASTM F1055</td>
<td>Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing</td>
</tr>
<tr>
<td>ASTM F1290</td>
<td>Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings</td>
</tr>
<tr>
<td>ASTM F1417</td>
<td>Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air</td>
</tr>
<tr>
<td>ASTM F1962</td>
<td>Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings</td>
</tr>
<tr>
<td>ASTM F2164</td>
<td>Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure</td>
</tr>
<tr>
<td>ASTM F2206</td>
<td>Standard Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE) Plastic Pipe, Fittings, Sheet Stock, Plate Stock, or Block Stock</td>
</tr>
<tr>
<td>ASTM F2620</td>
<td>Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings</td>
</tr>
<tr>
<td>NSF/ANSI 61</td>
<td>Drinking Water System Components–Health Effects</td>
</tr>
<tr>
<td>PPI TR-4</td>
<td>PPI Listing of Hydrostatic Design Basis (HDB), Strength Design Basis (SDB), Pressure Design Basis (PDB) and Minimum Required Strength Ratings for Thermoplastic Piping Materials for Pipe</td>
</tr>
</tbody>
</table>

B. MANUFACTURER REQUIREMENTS

1. High density polyethylene (HDPE) pipe and fittings shall be manufactured in accordance with the following standards:
   a. ASTM D3035 – ½ in through 24-in pipe
   b. ASTM F714 – 3-in through 54-in pipe
   c. AWWA C901 – 1/2 In. (130mm) through 3 In. (76 mm) pipe and tubing
   d. AWWA C906 – 4 In. (100 mm) through 63 In (1,600 mm) pipe and fabricated fittings
   e. ASTM D3261 – butt fusion fittings, saddles and flange adapters
   f. ASTM F1055 – electrofusion couplings and saddles.
   g. ASTM F2206 – fabricated fittings

C. FUSION TECHNICIAN REQUIREMENTS

1. Each Fusion Technician shall be separately qualified to make each type of fusion joint. Fusion joint types are butt fusion, saddle fusion and electrofusion. Qualification to make one type of fusion joint shall not qualify a Fusion Technician to make a different type of fusion joint. Each technician shall have a documented installation of a minimum of 5,000 linear feet.

2. Each Fusion Technician making butt fusion joints shall be qualified to make butt fusion joints in accordance with ASTM F2620. Qualification shall have occurred not more than 12 months before performing fusion joining on site in accordance with this specification. Qualification shall be a documented demonstration of proficiency by making joints in accordance with ASTM F2620 that are proved to be satisfactory by destructive testing in accordance with ASTM F2620. Each technician shall have a documented installation of a minimum of 5,000 linear feet.

3. Each Fusion Technician making saddle fusion joints shall be qualified to make saddle fusion joints in accordance with ASTM F2620. Qualification shall have
occurred not more than 12 months before performing on-site fusion joining in accordance with this specification. Qualification shall be a documented demonstration of proficiency by making joints in accordance with ASTM F2620 that are proved to be satisfactory by destructive testing in accordance with ASTM F2620.

4. Each Fusion Technician making electrofusion fitting joints shall be qualified to make electrofusion fitting joints in accordance with ASTM F1290 and the electrofusion fitting manufacturer’s recommended procedure. Qualification shall have occurred not more than 12 months before performing on-site fusion joining in accordance with this specification. Qualification shall be a documented demonstration of proficiency by making joints in accordance with ASTM F1290 and the electrofusion fitting manufacturer’s recommended procedure that are proved to be satisfactory by destructive testing in accordance with ASTM F1290 and the electrofusion fitting manufacturer’s recommended procedure.

D. APPROVED SUPPLIERS

1. Pipe and fitting suppliers:
   a. The following pipe manufacturers are approved:
      1) JM Eagle
      2) Chevron Phillips Performance Pipe
      3) ISCO Industries, LLC
      4) WL Plastics
   b. The following fitting manufacturers are approved:
      1) JM Eagle
      2) Chevron Phillips Performance Pipe
      3) ISCO Industries, LLC
      4) WL Plastics

E. WARRANTY

1. Pipe and fitting suppliers shall provide a one-year warranty covering defects in product material and workmanship. A successful pressure test or pressure leak test prior to the expiration of the warranty period shall not relieve the supplier of warranty responsibility for the full warranty term.

2. Fusion providers shall provide a one-year warranty from the date of installation acceptance covering defects in fusion joining workmanship that shall provide for remaking defective butt fusion, saddle fusion or electrofusion joints. A successful pressure test or pressure leak test prior to the expiration of the warranty period shall not relieve the installer of warranty responsibility for the full warranty term.

F. SUBMITTALS

1. The following information shall be submitted by pipe and fitting suppliers:
   a. Name of the pipe manufacturer and a list of the piping and quantities to be provided by manufacturer.
   b. Name(s) of fitting manufacturer(s) and lists of fittings and quantities to be provided by manufacturer.
   c. Pipe and fitting product data indicating conformance with this specification, applicable standards, and warranty provisions, including
written documentation regarding any intended variance from this specification and applicable standards.

d. At the time of shipment, the supplier shall provide certified documentation of pipe and fitting conformance with this specification and applicable pipe and fitting standards specified herein.

2. The following information shall be submitted by Fusion Providers.
   a. Documentation that each Fusion Technician has met requirements for joining proficiency for each type of fusion joint performed by the Fusion Technician under this specification.
   b. Documentation of conformance with this specification and applicable standards, including written documentation regarding any intended variance from this specification and applicable standards. This will include fusion joint warranty information and recommended project specific fusion parameters, including criteria logged and recorded by data logger.
   c. The following AS-RECORDED DATA is required from the Contractor and/or Fusion Provider:
      1) Fusion reports for each fusion joint performed on the project, including joints that were rejected. Submittals of the Fusion Technician’s joint reports are required as requested by the Owner or Engineer. Specific requirements of the Fusion Technician’s joint report shall include:
         (a) Pipe or fitting size and DR or pressure class rating
         (b) Fusion equipment size and identification
         (c) Fusion Technician Identification
         (d) Job Identification Number
         (e) Fusion Number
         (f) Fusion joining parameters
         (g) Ambient Conditions

PART 2 – PRODUCTS

2.01 PIPE AND FITTINGS FOR PRESSURE POTABLE WATER SERVICE

A. PE4710 pipe and fitting material compound:
   1. PE4710 material compound shall conform to material requirements specified in ASTM F714 as applicable for the pipe or fitting. PE4710 material shall meet the requirements of ASTM D3350 and shall meet or exceed a cell classification of 445574 per ASTM D3350.
   2. PE4710 material compound shall have a hydrostatic design stress (HDS) rating for water at 73°F (23°C) of not less than 1,000 psi that shall be documented in the name of the pipe manufacturer in PPI TR-4.
   3. PE4710 material compound shall have a hydrostatic design basis (HDB) rating at 140°F (60°C) of not less than 1,000 psi that shall be documented in the name of the pipe manufacturer in PPI TR-4.
   4. PE4710 pipe and fitting material compound in PE4710 pipe and fittings shall contain color and ultraviolet (UV) stabilizer meeting the requirements of Code C
or E per ASTM D3350. Code C material shall contain 2 to 3 percent carbon black to provide indefinite protection against UV degradation when material from the pipe is tested in accordance with ASTM D1603 or ASTM D4218. Code E material used for coextruded OD color stripes or a coextruded ID color layer shall contain sufficient UV stabilizer to protect the pipe against UV degradation for at least 24 months of unprotected outdoor exposure. Coextruded color PE compound material shall be PE4710 pipe material compound, varying only by color and UV stabilizer.

5. Clean rework materials derived from pipe production by the same manufacturer are acceptable as part of a blend with virgin material for the production of new pipe or tubing provided that the rework material is the same PE4710 material designation as the virgin material compound to which it is added. Finished products containing rework material shall meet the requirements this specification.

6. Qualification for potable water service. PE4710 compounds shall be tested and certified as suitable for use with potable water in accordance with requirements that are no less restrictive than the applicable requirements in NSF/ANSI 61.

B. PE4710 pipe and butt fusion fittings shall have plain ends for butt fusion.

C. PE4710 pipe:

1. Nominal straight lengths of 3 inch and larger pipe shall be 40 ft. or 50 ft.

2. Nominal coil lengths of 4-inch and smaller pipe shall be 500 ft. Longer or shorter coils such as 800 ft for 4-inch pipe, 1000 ft for 3-inch pipe, or 2000 ft for 2 inch or smaller pipe shall be acceptable.

3. Pipe shall be black with coextruded OD blue stripes.

4. Pipe shall be permanently marked using heated indent printing in accordance with ASTM F714 as applicable for the pipe size including:
   a. Nominal size and sizing system, e.g., IPS or DIOD
   b. PE4710 material designation
   c. DR or SDR
   d. Standard Designation, e.g., ASTM F714
      1) The Standard Designation marking on the pipe shall serve as the manufacturer’s certification that the pipe has been manufactured, sampled and tested and has been found to comply with the requirements of the standard.
   e. NSF-61 mark verifying suitability for potable water service
   f. Extrusion production-record code
   g. Manufacturer’s Trademark or trade name

D. PE4710 fittings:

1. PE4710 butt fusion, saddle fusion, electrofusion and fabricated fittings shall be manufactured from PE4710 material compound in accordance with this specification.

2. PE4710 fittings shall comply with ASTM D3261 for molded butt fusion and saddle fusion fittings, flange adapters and MJ adapters, or shall comply with ASTM F2206 for fabricated butt fusion fittings, or shall comply with ASTM F1055 for electrofusion fittings.
3. PE4710 fittings shall comply with the marking requirements of ASTM D3261 for molded butt and saddle fusion fittings, flange adapters and MJ adapters or shall comply with the marking requirements of ASTM F2206 for fabricated butt fusion fittings, or shall comply with the marking requirements of ASTM F1055 for electrofusion fittings.

   a. Marking shall include the NSF-61 mark verifying suitability for potable water service.

4. PE4710 fittings shall have pressure class ratings not less than the pressure class rating of the pipe to which they are joined.

2.02 PIPE AND FITTINGS FOR PRESSURE OR NON-PRESSURE WASTEWATER SERVICE

A. PE4710 pipe and fitting material compound:

1. PE4710 material compound shall conform to material requirements specified in ASTM F714 as applicable for the pipe or fitting. PE4710 material shall meet the requirements of ASTM D3350 and shall meet or exceed a cell classification of 445474 per ASTM D3350.

2. PE4710 material compound shall have a hydrostatic design stress (HDS) rating for water at 73°F (23°C) of not less than 1000 psi that shall be documented in the name of the material manufacturer in PPI TR-4.

3. PE4710 pipe and fitting material compound in PE4710 pipe and fittings shall contain color and ultraviolet (UV) stabilizer meeting the requirements of Code C or E per ASTM D3350. Code C material shall contain 2 to 3 percent carbon black to provide indefinite protection against UV degradation when material from the pipe is tested in accordance with ASTM D1603 or ASTM D4218. Code E material used for coextruded OD color stripes or a coextruded ID color layer shall contain sufficient UV stabilizer to protect the pipe against UV degradation for at least 24 months of unprotected outdoor exposure. Coextruded color PE compound material shall be PE4710 pipe material compound, varying only by color and UV stabilizer.

4. Clean rework materials derived from pipe production by the same manufacturer are acceptable as part of a blend with virgin material for the production of new pipe or tubing provided that the rework material is the same PE4710 material designation as the virgin material compound to which it is added. Finished products containing rework material shall meet the requirements this specification.

B. PE4710 pipe and butt fusion fittings shall have plain ends for butt fusion.
C. PE4710 pipe:
   1. Nominal straight lengths of 3 inch and larger pipe shall be 40 ft. or 50 ft.
   2. Nominal coil lengths of 4-inch and smaller pipe shall be 500 ft. Longer or shorter coils such as 800 ft for 4-inch pipe, 1000 ft for 3-inch pipe, or 2000 ft for 2 inch or smaller pipe shall be acceptable.
   3. Pipe shall be black. Coextruded OD green stripes shall be an acceptable option. A coextruded light grey or light green color ID layer to facilitate video ID inspection shall be an acceptable option.
   4. Pipe shall be permanently marked using heated indent printing in accordance with ASTM F714 as applicable for the pipe size including:
      a. Nominal size and sizing system, e.g., IPS or DIOD
      b. PE4710 material designation
      c. DR or SDR
      d. Standard Designation, e.g., ASTM F714:
         1) The Standard Designation marking on the pipe shall serve as the manufacturer’s certification that the pipe has been manufactured, sampled and tested and has been found to comply with the requirements of the standard.
      e. Extrusion production-record code
      f. Manufacturer’s Trademark or trade name

D. PE4710 fittings:
   1. PE4710 butt fusion, saddle fusion, electrofusion and fabricated fittings shall be manufactured from PE4710 material compound in accordance with this specification.
   2. PE4710 fittings shall comply with ASTM D3261 for molded butt fusion and saddle fusion fittings, flange adapters and MJ adapters, or shall comply with AWWA C906 or ASTM F2206 for fabricated butt fusion fittings, or shall comply with ASTM F1055 for electrofusion fittings.
   3. PE4710 fittings shall comply with the marking requirements of ASTM D3261 for molded butt and saddle fusion fittings, flange adapters and MJ adapters or shall comply with the marking requirements of AWWA C906 or ASTM F2206 for fabricated butt fusion fittings, or shall comply with the marking requirements of ASTM F1055 for electrofusion fittings.

2.04 FUSION JOINTS
A. Unless otherwise specified, PE4710 pipe and fittings shall be assembled in the field with butt fusion, saddle fusion or electrofusion joints. ASTM F2620 and the pipe manufacturer’s recommended procedure shall be observed for butt fusion and saddle fusion joints. ASTM F1290 and the electrofusion fitting manufacturer’s recommended joining procedure shall be observed for electrofusion joints.
B. Field butt fusion, saddle fusion and electrofusion joints shall be made by Fusion Technicians that are qualified in accordance with this specification to make the specific fusion joint type.
C. Field fusion joints shall be recorded and documented in accordance with this specification.
2.05 CONNECTIONS AND FITTINGS FOR PRESSURE APPLICATIONS

A. Connections shall be defined in conjunction with the linking of project piping, as well as the tie-ins to other piping systems.

B. MECHANICAL FITTINGS

1. Acceptable mechanical fittings for use with PE4710 pipe and fittings shall be mechanical fittings that are qualified by the mechanical fitting manufacturer for use with PE4710 pipe and fittings.

2. Mechanical fittings for use with HDPE pipe shall provide restraint against longitudinal separation that is inherent to the design of the joint. Mechanical joints that do not provide restraint against pull-out or push-off are prohibited.

3. Mechanical connections to non-HDPE devices and appurtenances shall be by bolted flange adapter or MJ adapter. Flange adapter and MJ adapter connections shall be assembled and tightened in accordance with flange adapter or MJ adapter manufacturer’s instructions.

C. GASKETED, PUSH-ON FITTINGS

1. Gasketed push-on fittings shall be fitted with external mechanical restraints that span across the joint and are assembled in accordance with restraint manufacturer’s instructions.

   a. Thrust blocking does not provide acceptable restraint and is prohibited.

   b. Where plain-end PE4710 pipe is assembled with push-on fittings, the PE4710 pipe end shall be fitted with electrofusion restraints so that external mechanical restraint may be secured to the PE4710 pipe.

2. Where PE4710 pipe is connected to gasketed mechanical joint fittings or appurtenances, the connection shall be made by butt fusing a PE4710 Adapter to the PE4710 pipe and connecting the PE4710 MJ Adapter to the mechanical joint fitting or appurtenance.

D. SLEEVE-TYPE COUPLINGS

1. Sleeve-type mechanical couplings shall be manufactured for use with PE4710 pipe, and shall be restrained as indicated on the drawings and in these specifications. Unrestrained sleeve-type couplings are prohibited.

E. EXPANSION AND FLEXIBLE COUPLINGS

1. Expansion-type mechanical couplings are prohibited.

F. CONNECTION HARDWARE

1. Bolts and nuts for buried service shall be made of non-corrosive, high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21.11, regardless of any other protective coating.

2.07 CONNECTIONS FOR NON-PRESSURE SEWER OR WASTEWATER APPLICATIONS

A. The following connections are to be used in conjunction with tie-ins to other non-pressure sewer piping and structures, and shall be as indicated on the drawings.

B. SLEEVE-TYPE COUPLINGS:

1. Sleeve-type mechanical couplings shall be manufactured for use with non-pressure PE4710 pipe, and may be restrained or unrestrained as indicated on the drawings and in these specifications.
C. CONNECTION HARDWARE

1. Bolts and nuts for buried service shall be made of non-corrosive high strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating.

D. CONNECTION TO NON-PRESSURE MANHOLES AND STRUCTURES

1. Non-pressure PE4710 pipe and fittings shall be connected to manholes and other structures to provide a leak-free, properly graded flow into or out of the manhole or structure.

2. Connections to existing manholes and structures shall be as specified and shown on the drawings.
   a. For a cored or drilled opening provide a flexible, watertight connection that meets and/or exceeds ASTM C923.
   b. For a knock out opening, provide a watertight connection (waterstop or other method) meeting the material requirements of ASTM C923 that is securely attached to the pipe with stainless steel bands or other means.
   c. Grout opening in manhole wall with non-shrink grout. Pour concrete collar around pipe and outside manhole opening.

3. Connections to a new manhole or structure shall be as specified and shown on the drawings.
   a. A flexible, watertight gasket per ASTM C 923 shall be cast integrally with riser section(s) for all precast manhole and structures.
   b. Drop connections shall be required where shown on drawings.
   c. Grout internal joint space with non-shrink grout.

PART 3 -- EXECUTION

3.01 DELIVERY AND OFF-LOADING

A. All piping shall be bundled or packaged for transportation by commercial carrier to the site.

B. Before off-loading, pipe shall be inspected for damage. Any pipe damaged in shipment shall be assessed and either accepted or rejected as directed by the Owner or Engineer, and the pipe supplier shall be notified of rejected pipe within 7 days of delivery at the site. Rejected pipe shall be quarantined for disposition. Each pipe shipment shall be checked for quantity and proper pipe size, color and type.

C. Pipe shall be off-loaded and handled in accordance with the pipe manufacturer's instructions and AWWA M55.

3.02 HANDLING AND STORAGE

A. Pipe lengths should be placed and stored on level ground. Pipe should be stored at the job site in the unit packaging provided by the manufacturer. The interior of the pipe, as well as all end surfaces, should be kept free from dirt and foreign matter.

B. Pipe shall be handled and supported with the use of woven fiber pipe slings or approved equal. Care shall be exercised when handling the pipe to not cut, gouge, scratch or otherwise abrade the piping in any way. Use of hooks, chains, wire rope or any other handling device which creates the opportunity to damage the surface of the pipe is strictly prohibited.
C. Covering or shading of PE4710 pipe and fittings against exposure to ultraviolet light from sunlight is not required.

3.03 FUSION PROCESS
A. GENERAL

1. Butt and saddle fusion of PE4710 pipe and fittings shall be in accordance with ASTM F2620 and the manufacturer’s recommended joining procedure.

2. Electrofusion of PE4710 pipe and fittings shall be performed in accordance with ASTM F1290 and the electrofusion fitting manufacturer’s recommended procedure.

3. PE4710 pipe and fittings shall be fused by qualified fusion technicians, as documented by the fusion provider. Training records for qualified fusion technicians shall be available to Owner or Engineer upon request.

4. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) affixed to the fusion machine. Joint data shall be submitted as part of the As-Recorded information, in accordance with this specification.

5. Butt fusion machines shall incorporate the following properties, including the following elements:
   a. HEAT PLATE – Heat plates and the non-stick coatings on heating surfaces shall be in good condition without heating surface gouges or scratches. The non-stick coating shall be intact, clean and free of any contamination. Heater controls and temperature indicators shall function properly, and electrical cords and connections shall be in good condition. The heat plate shall maintain a uniform and consistent temperature on all areas of the heating surfaces on both sides of the heat plate.
   b. CARRIAGE – Carriage shall travel smoothly with no binding at less than 50 psi for hydraulic fusion machines. Clamps shall be in good condition with proper inserts for the pipe size being fused.
   c. GENERAL MACHINE - Overview of machine body shall yield no obvious defects, missing parts, or potential safety issues during fusion.
   d. DATA LOGGER - The current version of the pipe supplier’s recommended and compatible software shall be used. Protective case shall be utilized for the hand held wireless portion of the unit. Data logger operations and maintenance manual shall be with the unit at all times. If fusing for extended periods of time, an independent 110V power source shall be available to extend battery life.

6. Other equipment specifically required for fusion processes shall include the following:
   a. Pipe rollers shall be used to support pipe to either side of the butt fusion machine and provide for vertical and lateral pipe alignment straight through the butt fusion machine.
   b. A protective enclosure that provides for full machine motion of the clamps, heat plate, fusion assembly and carriage shall be provided for fusion in inclement and/or windy weather. Pipe ends shall be covered or blocked where open pipe ends could allow prevailing winds to blow through the pipe.
   c. Do Not Fuse: during periods of precipitation or wind speeds in excess of 20 MPH.
When fusing in cold weather:
Maintain the specified heating tool temperature. Do not increase the tool
surface temperature.

1) Do not apply pressure during zero pressure butt fusion heating
steps.

2) Do not increase butt fusion joining pressure.

d. Fusion machine operations and maintenance manual shall be kept with
the fusion machine at all times.

E. JOINT RECORDING

1. Each fusion joint shall be recorded and logged by an electronic monitoring device
(data logger) connected to the fusion machine that shall register and/or record
the parameters required by the manufacturer and these specifications. Data not
logged by the data logger shall be logged manually and be included in the Fusion
Technician’s joint report.

3.04 INSTALLATION

A. The PE4710 pipe and fittings will be installed such that PE4710 pipe curvature is not less
than the minimum bending radius recommended by the pipe manufacturer.

B. Direct burial installation of PE4710 pressure pipe shall be in accordance with ASTM
D2774 and the pipe manufacturer’s recommendations.

C. Direct burial installation of PE4710 non-pressure pipe shall be in accordance with ASTM
D2321 and the pipe manufacturer’s recommendations.

D. Installation of PE4710 pipe by horizontal directional drilling shall be in accordance with
ASTM F1962 and the pipe manufacturer’s recommendations.

E. Installation of PE4710 pipe by slip lining or insertion within a casing or host pipe shall be
in accordance with ASTM F585 and the pipe manufacturer’s recommendations.

F. Tracer Wire – All PE4710 piping shall be installed with a continuous, insulated TW, THW,
THWN, or HMWPE insulated copper, 10 gauge or thicker wire for pipeline location
purposes by means of an electronic line tracer.

1. The wires shall be installed along the entire length of the pipe.

2. The insulation color shall match the service color of the pipe being installed.
Blue shall be used for potable water; green for wastewater or sanitary sewer; and
purple or lavender for non-potable or reclaimed water.

3. Sections of wire shall be spliced together using approved splice caps and
waterproof seals. Twisting the wires together is not acceptable.

3.05 MAKING CONNECTIONS TO NON-PE4710 PIPING SYSTEMS

A. Approximate locations for non-PE4710 piping systems are shown on the drawings or
detailed in the specifications. Prior to making connections into existing piping systems,
the Contractor shall:

1. Verify the actual field location, size, piping material and service of non-PE4710
piping systems.

2. Obtain all required non-PE4710 piping manufacturer(s) approved fittings (i.e.,
saddles, sleeve type couplings, flanges, tees, etc., as shown).

3. Have installed all temporary pumps and/or pipes in accordance with established
connection plans.
4. Have on hand pipe stoppers, blind flanges or other devices to seal a valve or appurtenance that fails to seal properly. When applied to pressure rated valves or appurtenances, all such devices shall be pressure rated equal to or greater than the pressure rating of the valve or appurtenance to which they are attached.

B. Where PE4710 pipe connects in-line to unrestrained gasketed push-on piping, the end of the PE4710 pipe shall be anchored in-line within 10 ft of the connection to prevent longitudinal movement of the PE4710 pipe.

1. The PE4710 pipe shall be fitted with a PE4710 wall anchor or electrofusion flex restraints.

2. The PE4710 wall anchor or electrofusion flex restraints shall be encased in reinforced concrete that is sufficient to withstand Poisson effect longitudinal loads in accordance with AWWA M55 In-Line Anchoring.

C. Unless otherwise approved by the Engineer, new piping systems shall be completely assembled and successfully tested prior to making connections to non-PE4710 piping systems.

3.06 PIPE SYSTEM CONNECTIONS

A. Pipe connections shall be installed per applicable standards and regulations, as well as per the connection manufacturer’s recommendations and as indicated on the drawings. Pipe connections to structures shall be installed per applicable standards and regulations, as well as per the connection manufacturer’s recommendations.

3.07 TRACER WIRE TESTING

A. Upon completion of installation by direct burial, sliplining, directional boring or pipe bursting, the Contractor shall demonstrate that the tracer wire is continuous and unbroken through the entire run of the pipe.

1. Demonstration shall include full signal conductivity (including splices) when energizing for the entire run in the presence of the Owner or Engineer.

2. If the wire is broken, the Contractor shall repair or replace it. Pipeline installation will not be accepted until the tracer wire passes a continuity test.

3.08 TAPPING FOR POTABLE AND NON-POTABLE WATER APPLICATIONS

A. Tapping shall be performed using standard saddle fusion fittings, electrofusion saddle fittings, or mechanical tapping saddles or sleeves designed for use on PE4710 piping. Tapping by threading directly into the PE4710 pipe wall is prohibited.

B. Branching connections requiring a larger diameter shall be made with saddle fusion branch saddle fittings or mechanical branch connection fittings as specified and indicated on the drawings.

C. Equipment used for tapping shall be made specifically for tapping PE4710 pipe:

1. Tapping bits shall be slotted “shell” style cutters, specifically made for PE4710 pipe. ‘Hole saws’ made for cutting wood, steel, ductile iron, or other materials are strictly prohibited.

2. Manually operated or power operated drilling machines may be used.

D. Taps may be performed while the pipeline is filled with water and under pressure (‘wet’ tap), or when the pipeline is not filled with water and not under pressure (‘dry’ tap).
3.09 TESTING

A. Testing shall comply with all local building codes, statutes, standards, local jurisdiction, and laws.

B. Segments of the pipe may be tested separately in accordance with standard testing procedure, as approved by the Owner and Engineer.

C. HYDROSTATIC LEAKAGE TESTING FOR PRESSURE PIPING

1. Hydrostatic leakage testing shall comply with 30 TAC 290.44(A)(5).

2. Pneumatic (compressed air) leakage testing of PE4710 pressure piping is prohibited.

D. LEAKAGE TESTING FOR NON-PRESSURE PIPING

1. Non-pressure piping such as gravity sewers shall be tested in accordance with 30 TAX 217.57

E. DISINFECTION OF THE PIPELINE FOR POTABLE WATER PIPING

1. After installation, the pipeline, having passed all required testing, shall be disinfected prior to being put into service. Unless otherwise directed by the Owner or Engineer, the pipeline will be disinfected per AWWA C651.

2. Dechlorination of disinfecting water shall be in strict accordance with current AWWA Standard C655-09 or most recent and Section 330510 “Dechlorination Activities”.

END OF SECTION 334105