

PROJECT MANUAL FOR

Brackenridge Park – Upper Labor, Acequia and Pump House

**A Project for:
The City of San Antonio**

PROJECT ADDRESS:

**3700 N ST MARY'S STREET, SAN ANTONIO, TX 78212 (SITE)
3700 N ST MARY'S STREET, BUILDING #13, SAN ANTONIO, TX 78212 (HISTORIC PUMPHOUSE)**



**Project No.
SWA No. CNOs701**

**95% Construction Documents
30 MAY 2025**

prepared by:

swa

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END of SECTION - 000002

DIVISION 01

General Conditions

95% Construction Documents

SECTION 01 04 50 - CUTTING AND PATCHING

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Uniform General Conditions, Supplementary General Conditions, Forms, applicable Specification Sections found in all other Divisions, and all Drawings apply to Work specified in this Section.

B. DESCRIPTION

Cutting and patching includes demolition and cutting into existing construction to provide for the installation or performance of the intended Work and subsequent fitting and patching required to restore surfaces to the intended or original condition.

Cutting and patching is performed for coordination of the work, uncover work for access or inspection, obtain samples for testing, permit alterations, and/or other similar conditions.

Modification to products during the manufacturing process, during initial fabrication, erection or installation is not considered to be cutting and patching under this definition.

Demolition and roof removal processes are not cutting and patching. Interior ceiling work related to installation of the roof drains and piping is considered cutting and patching.

C. SUBMITTALS

Submit written requests outlining the scope of work and methods in advance of cutting and patching involving:

Structural elements;

Integrity of weather-exposed or moisture-resistant elements;

Efficiency, maintenance or safety of any operational equipment within the building;

Sight-exposed elements;

Work of Owner being performed under separate contract.\

Each request shall include the following:

1. Identification of Project
2. Location and description of affected Work
3. Reason for alteration
4. Description of the products to be incorporated in the process.
5. Scope of cutting, patching, alteration and/or excavation including physical limitations
6. Trades executing the Work
7. Extent of re-finishing.
8. Alternatives, if any.
9. Written authorization or permission of affected contractors / subcontractors.
10. Date, time and duration of the intended Work.

D. QUALITY ASSURANCE

Only workers trained and skilled in the intended work shall be employed.

Cutting and patching of any structural element shall not be performed without advance inspection by a Structural Engineer.

PART 2 -PRODUCTS

A. MATERIALS

Except as other indicated, or as directed by the Owner directly, materials incorporated into the cutting and patching process shall be identical to existing materials. If these materials are not available, or conditions prevent their use, materials shall be incorporated that match the existing as closely as possible. Materials incorporated in the Work shall be of the same or better quality than those removed. Submit a request for substitution in advance of the use of non-matching materials.

PART 3 -EXECUTION

A. GENERAL

Execute cutting, fitting and patching, including excavation and fill as required to provide a complete and finished installation.

Work shall be neatly fitting and matched to the surrounding integrating consistently with existing materials.

Remove and replace any work that is found to be unacceptable or defective.

Samples removed and testing shall only be done in the presence of the Architect and/or Owner, and any other interested party such as material manufacturers, suppliers, subcontractors, etc.

B. INSPECTION

Prior to cutting examine all existing surfaces to be affected and conditions under which the Work will be performed. If unsafe, or if conditions differ substantially from what is expected, stop work and inform the Architect and Owner immediately.

Identify existing conditions which are subject to movement or which may require bracing.

C. PREPARATION

Provide supports, bracing, warning barriers, and other elements to protect surrounding conditions.

Provide protection of elements subject to damage by this Work or from weather.

Prevent debris from entering the occupied building or into unintended spaces. Prevent product contamination.

D. CUTTING

The Work shall be performed continuously and without delay. Exposed portions of the building shall be closed on the same day to prevent water entry.

Cutting shall be accomplished with tools and methods intended for the purpose and providing the least damage to adjacent materials. Consult the Manufacturer of the existing materials to understand the best methods for removal and/or patching.

Small hand and/or power tools shall be employed for limited work. Unrestricted chopping and hammering shall be avoided. Core holes through concrete and masonry shall be accomplished with power coring drills specifically designed for the purpose. Holes and openings shall be cut to the minimum size possible for the intended Work. Provide temporary water tight coverings where the openings cannot be closed overnight. Provide temporary coverings where interior surfaces cannot be fully finished in the same day.

E. PATCHING

Patched seams shall be durable and unnoticeable. Comply with industry-recognized tolerances. Restore exposed finishes of cut openings and where necessary extend finish restoration into the retained adjoining surfaces in a manner that will eliminate evidence of patching and re-finishing.

Extend final paint coats, where applicable, over the entire unbroken surfaces containing the patch. Terminate at adjacent corners, ceilings, soffits, walks, floors, etc., where the paint cannot be fully matching in the local area of the repair.

Fit work air and watertight at pipes, sleeves, ducts, conduit and other penetrations passing through walls, roofs, floors, etc.

Thoroughly clean the finished surface and all adjacent surfaces.

END OF SECTION 01 0450

PART 1 - GENERAL

1.1 SCOPE

- A. This section defines and clarifies specific items of the Contract that are peculiar to the structural engineer's responsibilities. Refer to General Conditions for overall contractual agreements and to appropriate section of this specification for specifics on shop drawing, product data, and samples submitted.

PART 2 - GENERAL DEFINITIONS

2.1 STRUCTURAL ENGINEER OF RECORD

- A. The engineer responsible for the design of the primary structural system and whose seal/signature appears on the contract structural drawings. Responsibility for any secondary structural and non-structural systems not shown on the structural drawings rests with the prime professional, the architect.

2.2 SPECIALTY ENGINEER

- A. The engineer who is lawfully eligible to seal plans and designs for pre-engineered elements on systems which become part of the overall building.

2.3 GRADUATE ENGINEER

- A. The engineer who is an Engineer-In-Training and working under the direct supervision of a Licensed Engineer.

2.4 SUBMITTALS

- A. Items identified in the contract documents to be submitted by the contractor. Refer to individual sections of the specifications for specific items to be submitted.

2.5 FIELD OBSERVATIONS

- A. Visits to the jobsite by the structural engineer-of-record or his authorized representative to ascertain whether the work is generally in accordance with the structural contract documents. These observations are not exhaustive nor continuous.

PART 3 - PROCEDURAL REQUIREMENTS

3.1 SHOP DRAWINGS

- A. Refer to applicable section for specific requirements for number of copies to be submitted, time for review, etc. All submittals must come by way of the general contractor through the architect. Certain submittals, identified in specific sections of the specifications, generally regarding pre-engineered elements, will require a specialty engineer's seal and signature.

3.2 FIELD OBSERVATIONS

- A. Structural engineer shall be notified at least 24 hours in advance of any concrete pour or other action that will cover up structural elements that have not been reviewed by the structural engineer. Refer to individual sections for specific stages of construction which require observation.

3.3 ENGINEER'S ACTIONS

A. SHOP DRAWINGS

1. As per General or Special Conditions, the structural engineer will review shop drawings for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.
2. The structural engineer-of-record shall review the submittals and return them to the architect with one of the following statements checked off on the stamp:
3. "NO exceptions Taken" informs the Architect that the structural engineer takes no exception to the submittal being approved as per and in accordance with AIA Document 201, section 4.2.7.

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4. "Make Corrections Noted" informs the Architect that the structural engineer has made corrections on the submittals but otherwise takes no exception to the submittal being approved as per and in accordance with AIA Document 201, section 4.2.7.
 5. "Revise and Resubmit" indicates important items must be corrected and resubmitted. Marks on the submittal may not necessarily cover all of the defects of the submittal. This action expresses the structural engineer's concern and his recommendation to the Architect that the submittal be reviewed and resubmitted as per and in accordance with AIA Document 201, section 4.2.7.
 6. "Return One Corrected Copy For File" informs the Architect that the submittal may be approved as per AIA Document 201, section 4.2.7, but a corrected copy showing that corrections have been acknowledged must be returned for the structural engineer's file.
- 3.4 SHOP DRAWINGS WITH SPECIALTY ENGINEER'S SEAL AND SIGNATURE
- A. Certain shop drawings may be identified in specific sections of the specifications pertaining to pre-engineered structural elements specified by the structural engineer-of-record and designed by specialty engineers. The structural engineer shall verify that submittals have received prior approvals as required by the contract documents. Submittals shall bear the signature and professional seal of the specialty engineer responsible for the design as required by the contract documents. The structural engineer shall review the submittal for type, position, and connection to other elements within the primary structural system, and for criteria and loads used for their design. Action on these submittals will be the same as for other shop drawings.
 1. SHOP DRAWINGS FOR NON-STRUCTURAL ELEMENTS
 - a. Submittal of shop drawings covering items not shown or specified on structural plans by the Structural Engineer will be reviewed only to verify that the specialty engineer sealing the drawings/calculations has generally followed usual and customary application of code-mandated loads and design procedures. These submittals will be stamped "REVIEWED" indicating that the items listed interface with the primary structural framing without deleterious effect and no further action is taken.
- 3.5 SITE VISITS
- A. The structural engineer-of-record ("SER") will make site visits at intervals appropriate to the stage of construction and as defined by the contract to visually observe the quality and the progress of the construction work relative to the primary structural system. The general contractor is responsible to notify the SER when structural elements are ready for review and prior to their being covered up. Failure to do so may result in key observations not being made, preventing the engineer from recommending acceptance of the work. A written report will be made of each visit listing discrepancies, if any, and describing what was observed. One copy will be given to contractor's representative at the jobsite, and one copy will be mailed to the Architect. If a follow-up visit is necessary it will be so noted on the report.
 1. The SER shall not have control over or charge of and shall not be responsible for construction means, methods, techniques, sequences or procedures, or for safety precautions and programs in connection with the Work for This Part of the Project, since these are solely the Contractor's responsibility under the Contract for Construction. The SER shall not be responsible for the Contractor's or a Subcontractor's schedule or failure to carry out the Work in accordance with the Contract Documents. The SER shall not have control over or charge of acts or omissions of the Contractor, Subcontractors, their agents or employees or other persons performing portions of the Work.

END OF SECTION

SECTION 01 32 33 – PHOTOGRAPHIC DOCUMENTATION

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 administrative and procedural requirements for the following:
 - 1. Preconstruction photographs.
 - Periodic construction photographs.
 - Final completion construction photographs.
- B. Related Requirements:
 - 1. Section 013300 - Submittal Procedures: Submitting photographic documentation.
 - Section 017700 - Closeout Procedures: Submitting photographic documentation as project record documents at Project closeout.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional photographer.
- B. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation of construction. Include same information as corresponding photographic documentation.
 - 1. Provide a unique, sequential identifying number and date for each key plan submitted.
- C. Digital Photographs: Submit image files within seven (7) days of taking photographs.
 - 1. Digital Camera: Minimum sensor resolution of eight (8) megapixels.
Format: Minimum 3200 by 2400 pixels, in unaltered original files, with same aspect ratio as the sensor, uncropped, date and time stamped, in folder named by date of photograph, accompanied by key plan file.
Identification: Provide the following information with each image description in file metadata tag:
Name of Project.
Name of Project Owner.
Name and contact information for photographer.
Date photograph was taken.
Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
Unique sequential identifier keyed to accompanying key plan.
- D. Construction Photographs: Submit one (1) color print of each photographic view within seven (7) days of taking photographs.

Format: 5-by-7-inch smooth-surface matte prints on single-weight, acid-free, commercial-grade photographic paper; enclosed back to back in clear plastic sleeves that are punched for standard three-ring binder.

Identification: On back of each print, provide an applied label or rubber-stamped impression with the following information:

- Name of Project.
- Name of Project Owner.
- Name and contact information for photographer.

Date photograph was taken if not date stamped by camera.
Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
Unique sequential identifier keyed to accompanying key plan.
Digital Media: Submit digital media as described under Products below.

1.4 QUALITY ASSURANCE

- A. Photographer Qualifications: An individual who has been regularly engaged as a professional photographer of construction projects for not less than five (5) years.

1.5 USAGE RIGHTS

- A. Obtain and transfer copyright usage rights from photographer to Owner for unlimited reproduction of photographic documentation, with the stipulation of the photographer receiving proper citation or crediting for all reproduced photographic documentation.

PART 2 - PRODUCTS

2.1 DIGITAL PHOTOGRAPHIC MEDIA

- A. Digital Images: Provide color images in uncompressed TIFF format, produced by a digital camera with minimum sensor size of eight (8) megapixels, and at an image resolution of not less than 3200 by 2400 pixels.
Digital Storage Media: Submit digital image files on three (3) duplicate CD-R or DVD-R compact digital disks in plastic jewel cases, with labels on both digital disks and jewel cases corresponding to the applicable unique, sequential identifying number and date for the associated key plan.

PART 3 - EXECUTION

3.1 CONSTRUCTION PHOTOGRAPHS

- A. Photographer: Engage a qualified professional photographer to take construction photographs.

General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with improper exposure, blurry or out-of-focus areas will not be accepted.

1. Maintain key plan with each set of construction photographs that identifies each photographic location.

Take photographs from the same vantage points over the duration of the construction process so as to create consistent sequential views of progress.

Avoid the inclusion of construction personnel or other people in the construction photographs, unless documenting a critical construction procedure (e.g., dismantlement of historical material, etc.).

Provide a graphic scale indicator such as a ruler or photographic staff for photographs documenting detailed conditions that may lack a sense of scale or context otherwise.

- B. Digital Images: Submit digital images on digital media exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.

1. Date and Time: Include date and time in file name for each image.

Key Plan: Include a digital file (PDF Format) of the associated key plan on the same digital media containing the digital images.

Field Office Images: Maintain one set of digital images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Architect.

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- C. Preconstruction Photographs: Before starting construction and/or dismantling of historic features, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.
1. Flag construction limits before taking construction photographs.
Establish consistent vantage points, following suggestions by Architect, for exterior photographs for the building to be used throughout the construction process. Consistent vantage points will include, but may not be limited to, the following:
Views of the primary exterior elevations (north, south, east and west);
Oblique (corner) views of the four primary exterior elevations (views from the northeast, northwest, southeast and southwest).
Take a sufficient number of photographs of existing buildings on the property to accurately record physical conditions at start of construction.
Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
- D. Periodic Construction Photographs: Take an average of fifteen to twenty (15 to 20) color photographs to sufficiently document significant phases of the rehabilitation process. Select vantage points to show status of construction and progress since last photographs were taken.
1. Use consistent vantage points established during the preconstruction photographic documentation process in order to obtain a time-lapse record of construction process. Consistent vantage points will include, but may not be limited to, the following:
Views of the primary exterior elevations (north, south, east and west);
Oblique (corner) views of the four primary exterior elevations (views from the northeast, northwest, southeast and southwest).
Photographic documentation of the rehabilitation process should include, but is not limited to, the following activities:
Historic masonry and exterior stucco cleaning, including a detailed view of wall surfaces before and after cleaning;
Historic masonry repointing, repair and repainting;
Historic exterior stucco repair and repainting;
Historic window and door rehabilitation; including temporary sash removal for shop repairs, sash reinstallation after repairs, wood sill and wood trim repair and/or replacement.
- E. Final Completion Construction Photographs: Take eight to ten (8 to 10) color photographs after date of Substantial Completion for submission as project record documents. Architect will inform photographer of desired vantage points.
1. Do not include date stamp.

END OF SECTION 01 32 33

SECTION 01 35 91 – HISTORIC TREATMENT PROCEDURES

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 protection and treatment procedures for designated historic landscapes, site features, spaces, areas, rooms, and surfaces in Project.

1.3 DEFINITIONS

- A. Consolidate: To strengthen loose or deteriorated materials in place.
- B. Design Reference Sample: A sample that represents the Architect's pre-bid selection of work to be matched; it may be existing work or work specially produced for the Project.
- C. Dismantle: To disassemble or detach a historic item from a surface, or a non-historic item from a historic surface, using gentle methods and equipment to prevent damage to historic items and surfaces; disposing of items unless indicated to be salvaged or reinstalled.
- D. Historic: Spaces, areas, rooms, surfaces, materials, finishes, and overall appearance that are important to the successful preservation and rehabilitation as determined by Architect. Designated historic areas and structures are indicated on Drawings.
- E. Match: To blend with adjacent construction and manifest no apparent difference in material type, species, cut, form, detail, color, grain, texture, or finish as approved by Architect.
- F. Refinish: To remove existing finishes to base material and apply new finish to match original, or as otherwise indicated.
- G. Reinstall: To protect removed or dismantled item, repair and clean it as indicated for reuse, and reinstall it in original position, or where indicated.
- H. Remove: To take down or detach a non-historic item located within a historic space, area, or room, using methods and equipment to prevent damage to historic items and surfaces; disposing of items unless indicated to be salvaged or reinstalled.
- I. Repair: To correct damage and defects, retaining existing materials, features, and finishes while employing as little new material as possible. This includes patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading materials.
- J. Replace: To remove, duplicate, and reinstall entire item with new material. The original item is the pattern for creating duplicates unless otherwise indicated.
- K. Replicate: To reproduce in exact detail, materials, and finish unless otherwise indicated.
- L. Reproduce: To fabricate a new item, accurate in detail to the original, and from either the same or a similar material as the original, unless otherwise indicated.
- M. Restore: To consolidate, replicate, reproduce, repair, and refinish as required to achieve the indicated results.
- N. Retain: To keep existing items that are not to be removed or dismantled.
- O. Reversible: New construction work, treatments, or processes that can be removed or undone in the future without damaging historic materials unless otherwise indicated.
- P. Salvage: To protect removed or dismantled items and deliver them to Owner.
- Q. Stabilize: To provide structural reinforcement of unsafe or deteriorated items while maintaining the essential form as it exists at present; also, to reestablish a weather-resistant enclosure.
- R. Strip: To remove existing finish down to base material unless otherwise indicated.

1.4 COORDINATION

- A. Historic Treatment Subschedule: A construction schedule coordinating the sequencing and scheduling of historic treatment work for entire Project, including each activity to be performed in historic spaces, areas, and rooms, and on historic surfaces; and based on Contractor's Construction Schedule. Secure time commitments for performing critical construction activities from separate entities responsible for historic treatment work.
- a. Schedule construction operations in sequence required to obtain best historic treatment results.
 2. Coordinate sequence of historic treatment work activities to accommodate the following:
 - a. Other known work in progress.
 - b. Tests and inspections.
 3. Detail sequence of historic treatment work, with start and end dates.
 4. Utility Services: Indicate how long utility services will be interrupted, if required. Coordinate shutoff, capping, and continuation of utility services.

1.5 PROJECT MEETINGS FOR HISTORIC TREATMENT

- A. Preliminary Historic Treatment Conference: Before starting historic treatment work, Project Manager and Architect will conduct conference at the Project site.
1. Attendees: In addition to representatives of Owner, Project Manager, Architect, and Contractor, testing service representative, historic treatment specialists, chemical-cleaner manufacturer, and installers whose work interfaces with or affects historic treatment shall be represented at the meeting.
 2. Agenda: Discuss items of significance that could affect progress of historic treatment work, including review of the following:
 - a. Historic Treatment Sub-schedule: Discuss and finalize; verify availability of materials, historic treatment specialists' personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Fire-prevention plan.
 - c. Governing regulations.
 - d. Areas where existing construction is to remain and the required protection.
 - e. Hauling routes.
 - f. Sequence of historic treatment work operations.
 - g. Storage, protection, and accounting for salvaged and specially fabricated items.
 - h. Existing conditions, staging, and structural loading limitations of areas where materials are stored.
 - i. Qualifications of personnel assigned to historic treatment work and assigned duties.
 - j. Requirements for extent and quality of work, tolerances, and required clearances.
 - k. Methods and procedures related to historic treatments, including product manufacturers' written instructions and precautions regarding historic treatment procedures and their effects on materials, components, and vegetation.
 - l. Embedded work such as flashings and lintels, special details, collection of wastes, protection of occupants and the public, and condition of other construction that affect the Work or will affect the work.
 3. Reporting: Project Manager will record conference results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from conference.
- B. Coordination Meetings: Conduct coordination meetings specifically for historic treatment work at semi-monthly intervals. Coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and pre-installation conferences.
1. Attendees: In addition to representatives of Owner, Project Manager, Architect, and Contractor, each historic treatment specialist, supplier, installer, and other entity concerned with progress or involved in planning, coordination, or performance of historic treatment work activities shall be

represented at these meetings. All participants at conference shall be familiar with Project and authorized to conclude matters relating to historic treatment work.

2. Agenda: Review and correct or approve minutes of previous coordination meeting. Review other items of significance that could affect progress of historic treatment work. Include topics for discussion as appropriate to status of Project.
 - a. Historic Treatment Sub-schedule: Review progress since last coordination meeting. Determine whether each schedule item is on time, ahead of schedule, or behind schedule. Determine how construction behind schedule will be expedited with retention of quality; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities are completed within the Contract Time.
 - b. Schedule Updating: Revise Contractor's Historic Treatment Sub-schedule after each coordination meeting where revisions to schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each entity present, including review items listed in the "Preliminary Historic Treatment Conference" Paragraph above and the following:
 - 1) Interface requirements of historic treatment work with other Project Work.
 - 2) Status of submittals for historic treatment work.
 - 3) Access to historic treatment work.
 - 4) Effectiveness of fire-prevention plan.
 - 5) Quality and work standards of historic treatment work.
 - 6) Change Orders for historic treatment work.
3. Reporting: Project Manager will record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

1.6 MATERIALS OWNERSHIP

- A. Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to Owner that may be encountered or uncovered during the Work, regardless of whether they were previously documented, remain Owner's property.
 1. Carefully dismantle and salvage each item or object and protect it from damage, then promptly deliver it to Owner where directed.
 2. Coordinate with Architect, who will establish special procedures for dismantling and salvaging.

1.7 INFORMATIONAL SUBMITTALS

- A. Historic Treatment Sub-schedule:
 1. Submit historic treatment sub-schedule within 30 days of date established for commencement of historic treatment work.
- B. Preconstruction Documentation: Show preexisting conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by Contractor's historic treatment operations.
- C. Historic Treatment Program: Submit 30 days before work begins.
- D. Fire-Prevention Plan: Submit 30 days before work begins.

1.8 QUALITY ASSURANCE

- A. A. Historic Treatment Specialist(s) Qualifications: An experienced firm(s), with a minimum of seven (7) years in operation, regularly engaged in historic treatments similar in nature, materials, design, and extent to this work as specified in each section and that has completed a minimum of five recent projects within the last three (3) years with a record of successful in-service performance that demonstrates the firm's qualifications to perform this work.

1. Field Supervisor Qualifications: Full-time supervisors experienced in historic treatment work similar in nature, material, design, and extent to that indicated for this Project. Supervisors shall be on Project site when historic treatment work begins and during its progress. Supervisors shall not be changed during Project except for causes beyond the control of the specialist firm.
 - B. Historic Treatment Program: Prepare a written plan for historic treatment for whole Project, including each phase or process and protection of surrounding materials during operations. Describe in detail the materials, methods, and equipment to be used for each phase of work. Show compliance with indicated methods and procedures specified in this and other Sections. Coordinate this whole-Project historic treatment program with specific requirements of programs required in other historic treatment Sections.
 1. Dust and Noise Control: Include locations of proposed temporary dust- and noise-control partitions and means of egress from occupied areas coordinated with continuing on-site operations and other known work in progress.
 2. Debris Hauling: Include plans clearly marked to show debris hauling routes, turning radii, and locations and details of temporary protective barriers.
 - C. Fire-Prevention Plan: Prepare a written plan for preventing fires during the Work, including placement of fire extinguishers, fire blankets, rag buckets, and other fire-prevention devices during each phase or process. Coordinate plan with Owner's fire-protection equipment and requirements. Include fire-watch personnel's training, duties, and authority to enforce fire safety.
 - D. Safety and Health Standard: Comply with ANSI/ASSE A10.6.
- 1.9 STORAGE AND HANDLING OF HISTORIC MATERIALS
- A. Salvaged Historic Materials:
 1. Clean loose dirt and debris from salvaged historic items unless more extensive cleaning is indicated.
 2. Pack or crate items after cleaning; cushion against damage during handling. Label contents of containers.
 3. Store items in a secure area until delivery to Owner.
 4. Transport items to Owner's storage area on-site where indicated on Drawings.
 5. Protect items from damage during transport and storage.
 - B. Historic Materials for Reinstallation:
 1. Repair and clean historic items for reuse as indicated.
 2. Pack or crate items after cleaning and repairing; cushion against damage during handling. Label contents of containers.
 3. Protect items from damage during transport and storage.
 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment unless otherwise indicated. Provide connections, supports, and miscellaneous materials to make item functional for use indicated.
 - C. Existing Historic Materials to Remain: Protect construction indicated to remain against damage and soiling from construction work. Where permitted by Architect, items may be dismantled and taken to a suitable, protected storage location during construction work and reinstalled in their original locations after historic treatment and construction work in the vicinity is complete.
 - D. Storage: Catalog and store historic items within a weathertight enclosure where they are protected from moisture, weather, condensation, and freezing temperatures.
 1. Identify each item with a nonpermanent mark to document its original location. Indicate original locations on plans, elevations, sections, or photographs by annotating the identifying marks.
 2. Secure stored materials to protect from theft.
 3. Control humidity so that it does not exceed 85 percent. Maintain temperatures 5 deg F (3 deg C) or more above the dew point.
 - E. Storage Space:

1. Owner will arrange for limited on-site location(s) for free storage of historic material. This storage space does not include security and climate control for stored material.
2. Arrange for off-site locations for storage and protection of historic material that cannot be stored and protected on-site.

1.10 FIELD CONDITIONS

- A. Size Limitations in Historic Spaces: Materials, products, and equipment used for performing the Work and for transporting debris, materials, and products shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, including temporary protection, by 12 inches (300 mm) or more.

PART 2 - PRODUCTS - (Not Used)

PART 3 - EXECUTION

3.1 PROTECTION, GENERAL

- A. Protect persons, motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm resulting from historic treatment procedures.
 1. Use only proven protection methods, appropriate to each area and surface being protected.
 2. Provide temporary barricades, barriers, and directional signage to exclude the public from areas where historic treatment work is being performed.
 3. Erect temporary barriers to form and maintain fire-egress routes.
 4. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during historic treatment work.
 5. Contain dust and debris generated by historic treatment work, and prevent it from reaching the public or adjacent surfaces.
 6. Provide shoring, bracing, and supports as necessary. Do not overload structural elements.
 7. Protect floors and other surfaces along hauling routes from damage, wear, and staining.
- B. Temporary Protection of Historic Materials:
 1. Protect existing historic materials with temporary protections and construction. Do not remove existing materials unless otherwise indicated.
 2. Do not attach temporary protection to historic surfaces except as indicated as part of the historic treatment program and approved by Architect.
- C. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.
- D. Utility and Communications Services:
 1. Notify Owner, Architect, authorities having jurisdiction, and entities owning or controlling wires, conduits, pipes, and other services affected by historic treatment work before commencing operations.
 2. Disconnect and cap pipes and services as required by authorities having jurisdiction, as required for historic treatment work.
 3. Maintain existing services unless otherwise indicated; keep in service, and protect against damage during operations. Provide temporary services during interruptions to existing utilities.
- E. Existing Drains: Prior to the start of work in an area, test drainage system to ensure that it is functioning properly. Notify Architect immediately of inadequate drainage or blockage. Do not begin work in an area until the drainage system is functioning properly.
 1. Prevent solids such as stone or mortar residue or other debris from entering the drainage system. Clean out drains and drain lines that become sluggish or blocked by sand or other materials resulting from historic treatment work.

2. Protect drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.
- F. Existing Roofing: Replace of existing roof and augment existing roof structure prior to commencing historic treatment procedures.

3.2 PROTECTION FROM FIRE

- A. General: Follow fire-prevention plan and the following:
 1. Comply with NFPA 241 requirements unless otherwise indicated.
 2. Remove and keep area free of combustibles, including rubbish, paper, waste, and chemicals, unless necessary for the immediate work.
 - a. If combustible material cannot be removed, provide fire blankets to cover such materials.
 3. Prohibit smoking by all persons within Project work and staging areas.
- B. Heat-Generating Equipment and Combustible Materials: Comply with the following procedures while performing work with heat-generating equipment or combustible materials, including welding, torch-cutting, soldering, brazing, removing paint with heat, or other operations where open flames or implements using high heat or combustible solvents and chemicals are anticipated:
 1. Obtain Owner's approval for operations involving use of open-flame or welding or other high-heat equipment. Notify Owner at least 72 hours before each occurrence, indicating location of such work.
 2. As far as practicable, restrict heat-generating equipment to shop areas or outside the building.
 3. Do not perform work with heat-generating equipment in or near rooms or in areas where flammable liquids or explosive vapors are present or thought to be present. Use a combustible gas indicator test to ensure that the area is safe.
 4. Use fireproof baffles to prevent flames, sparks, hot gases, or other high-temperature material from reaching surrounding combustible material.
 5. Prevent the spread of sparks and particles of hot metal through open windows, doors, holes, and cracks in floors, walls, ceilings, roofs, and other openings.
 6. Fire Watch: Before working with heat-generating equipment or combustible materials, station personnel to serve as a fire watch at each location where such work is performed. Fire-watch personnel shall have the authority to enforce fire safety. Station fire watch according to NFPA 51B, NFPA 241, and as follows:
 - a. Train each fire watch in the proper operation of fire-control equipment and alarms.
 - b. Prohibit fire-watch personnel from other work that would be a distraction from fire-watch duties.
 - c. Cease work with heat-generating equipment whenever fire-watch personnel are not present.
 - d. Have fire-watch personnel perform final fire-safety inspection each day beginning no sooner than 30 minutes after conclusion of work at Project site to detect hidden or smoldering fires and to ensure that proper fire prevention is maintained.
 - e. Maintain fire-watch personnel at Project site until 60 minutes after conclusion of daily work.
- C. Fire Extinguishers, Fire Blankets, and Rag Buckets: Maintain fire extinguishers, fire blankets, and rag buckets for disposal of rags with combustible liquids. Maintain each as suitable for the type of fire risk in each work area. Ensure that nearby personnel and the fire-watch personnel are trained in fire-extinguisher and blanket use.

3.3 PROTECTION DURING APPLICATION OF CHEMICALS

- A. Protect motor vehicles, surrounding surfaces of building being restored, building site, plants, and surrounding buildings from harm or damage resulting from applications of chemicals and adhesives.
- B. Cover adjacent surfaces with protective materials that are proved to resist chemicals selected for Project unless chemicals being used will not damage adjacent surfaces as indicated in historic treatment program. Use covering materials and masking agents that are waterproof and UV resistant

and that will not stain or leave residue on surfaces to which they are applied. Apply protective materials according to manufacturer's written instructions. Do not apply liquid masking agents or adhesives to painted or porous surfaces. When no longer needed, promptly remove protective materials.

- C. Do not apply chemicals during winds of sufficient force to spread them to unprotected surfaces.
- D. Neutralize alkaline and acid wastes and legally dispose of off Owner's property.
- E. Collect and dispose of runoff from chemical operations by legal means and in a manner that prevents soil contamination, soil erosion, undermining of paving and foundations, damage to landscaping, or water penetration into building interior.

3.4 GENERAL HISTORIC TREATMENT

- A. Have historic treatment work performed only by qualified historic treatment specialists.
- B. Ensure that supervisory personnel are present when historic treatment work begins and during its progress.
- C. Record existing work before each procedure (preconstruction), and record progress during the work. Use digital preconstruction documentation photographs. Comply with requirements in Section 013233 "Photographic Documentation."
- D. Perform surveys of Project Site as the Work progresses to detect hazards resulting from historic treatment procedures.
- E. Follow the procedures in subparagraphs below and procedures approved in historic treatment program unless otherwise indicated:
 - 1. Retain as much existing material as possible; repair and consolidate rather than replace.
 - 2. Use additional material or structure to reinforce, strengthen, prop, tie, and support existing material or structure.
 - 3. Use reversible processes wherever possible.
 - 4. Use historically accurate repair and replacement materials and techniques unless otherwise indicated.
 - 5. Record existing work before each procedure (preconstruction) and progress during the work with digital preconstruction documentation photographs. Comply with requirements in Section 013233 "Photographic Documentation."
- F. Notify Architect of visible changes in the integrity of material or components whether from environmental causes including biological attack, UV degradation, freezing, or thawing or from structural defects including cracks, movement, or distortion.
 - 1. Do not proceed with the work in question until directed by Architect.
- G. Where missing features are indicated to be repaired or replaced, provide work with appearance based on accurate duplications rather than on conjecture, subject to approval of Architect.
- H. Where work requires existing features to be removed or dismantled and reinstalled, perform these operations without damage to the material itself, to adjacent materials, or to the substrate.
- I. Identify new and replacement materials and features with permanent marks hidden in the completed Work to distinguish them from original materials. Record a legend of identification marks and the locations of the items on record Drawings.

END OF SECTION 01 35 91

SECTION 015639 - TEMPORARY TREE AND PLANT PROTECTION

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.
- B. Tree protection and demolition notes as shown on the drawings.
- C. The City of San Antonio's Tree Preservation Ordinance, CH. 35, Sec. 523 of the City's Unified Development Code (UDC).

1.2 Reference Standards:

- 1. *American National Standard for Tree Care Operation, Tree, Shrub, and Other Woody Plant Maintenance (ANSI A300)*, American National Standards Institute, Latest Edition.
- 2. *American National Standard for Tree Care Operations (ANSI Z133)*, American National Standards Institute, Latest Edition.
- 3. *Tree Pruning Guidelines*, International Society of Arboriculture, 1995 Edition.
- 4. *Pruning Standards for Shade Trees*, National Arborists Association, Latest Edition.

1.3 SUMMARY

- A. Section includes general protection and pruning of existing trees and plants that are affected by execution of the Work, selection of suitable trees for timber and onsite mulching and stockpile, whether temporary or permanent construction.
- B. Related Sections:
 - 1. Section 024113 "Selective Site Demolition" for removing existing trees and shrubs.
 - 2. Section 024116 "Structural Demolition".
 - 3. Section 024296 "Historic Removal and Dismantling."
 - 4. Section 329300 "Plants".

1.4 DEFINITIONS

- A. Caliper: Diameter of a trunk measured by a diameter tape 24-inches (600mm) above the ground for trees up to, and including, 6-inch (100-mm) size; and larger size.
- B. Stockpile: Location(s) for onsite generated mulch from tree that are designated for removal.
- C. Timber: Trees designated for the salvaged of Timber.
- D. Tree-Protection Zone (TPZ): Area surrounding individual trees or groups of trees to be protected during construction.

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- E. Vegetation: Trees and shrub trees.

1.5 ACTION SUBMITTALS

- A. Contractor shall provide site photographs or videotape, sufficiently detailed and described, of existing conditions of trees and vegetation, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing, tree pruning, or tree protection. Submit photographs or videotape to the Landscape Architect prior to commencement of Work.
- B. Product Data: Submit complete and legible materials list of items to be provided for Work described herein this Section
1. List of equipment for onsite generated mulch.
 2. Organic hardwood mulch.
 3. Protection-Zone Signage: Full-size graphic samples of each size and text, ready for installation.
- C. Shop Drawings:
1. Protection-Zone Fencing: Submit scaled drawings showing all existing trees, identification of all species on the site and a verification of the tree disposition schedule as shown on the drawings certified by an ISA certified arborist. Show the extent and layout of tree protection fence layout on the site survey including overlay of the proposed site work and relevant notations and all tree fence protection and special condition details.
 2. Stockpile: Submit scaled drawings showing all existing trees, show the extent and layout of the mulch stockpiles on the site survey including overlay of the proposed site work and relevant notations and special condition details.
- D. Tree Disposition Schedule: Tree disposition has been recorded and is provided on the drawings. Verify the schedule detailing health condition, scope and extent of fencing or pruning of trees to remain that interfere with or are affected by construction.
1. Species by scientific name and common name. any submittals
 2. Tree dimensions, caliper, height and spread.
 3. 4x6-inch photograph(s) of each tree.
 4. Location on shop drawings. Include unique identifier for each if tag is missing.
 5. Tree disposition, roots, structure, branches and foliage.
 6. Reason for pruning.
 7. Description of pruning to be performed.
 8. Description of maintenance following pruning.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified arborist and tree service firm.
- B. Certification: From arborist, certifying 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.
- C. License: Valid City of San Antonio tree maintenance license.
- D. Data: Submit data showing source, size and composition for imported hardwood mulch if used.

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- E. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.
 - F. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.
 - 1. Use sufficiently detailed photographs or videotape.
 - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

1.7 QUALITY ASSURANCE

- A. Arborist Qualifications: Certified Arborist as certified by ISA.
- B. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.
- C. Preinstallation Conference: Pre-Tree Pruning/Tree Protection Conference: Contractor shall conduct a Pre-Tree Pruning/Tree Protection Conference at the Project Site with Certified Arborist (who will be on-site supervising the Work of the Project), the City Arborist, Architectural Historian, San Antonio Parks Department and the Landscape Architect.
 - 1. Contractor shall be responsible for notifying parties, in writing, at least seven (7) days in advance to schedule the Conference.
 - 2. Contractor shall provide to parties in attendance within seven (7) days a written legible inventory of Work to be accomplished, including species (botanical and common name), location, size, specific pruning needs or tree protection needs as identified during the Conference, recommended pruning or tree protection methods to meet the identified needs, and any additional conditions noted.
 - 3. Review methods and procedures related to temporary tree and plant protection including, but not limited to, the following:
 - a. Construction schedule. Verify availability of materials, personnel, and equipment needed to make progress and avoid delays.
 - b. Enforcing requirements for protection zones.
 - c. Arborist's responsibilities.
 - d. Field quality control.
 - e. Stockpile locations.
 - f. Timber identification.
- D. Pruning and remedial work shall be done under the direct supervision of an Arborist certified by the International Society of Arborists (ISA); or Arborist who is a member in good standing in the American Society of Consulting Arborists, in compliance with ISA and ANSI Standards. Arborist shall be on Site continuously while existing trees or roots are being pruned or remedial work is being performed.

1.8 SITE PROJECT CONDITIONS

- A. Contractor shall become aquatinted with existing site conditions, verifying quantities and locations of all protected trees and vegetation, and other information as may be necessary. Notify the Landscape Architect of unsatisfactory conditions, in writing, prior to commencement of Work.
- B. Tree Flagging: Prior to commencement of Work, Contractor shall flag existing trees and vegetation to remain and protected throughout the duration of Work. Adequately flag tree trunks with bright-colored tape (neon colors preferred). Verify flagged trees and vegetation with the Landscape Architect.
- C. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during tree-pruning or tree-protection operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways, if required, by authorities having jurisdiction.
- D. Locate above utilities prior to any Work, and perform Work in a manner which will avoid possible damage. Notify utility locator service for area where Project is located before site clearing where applicable. Notify the Landscape Architect if conflicts exist.
- E. Improvements on Adjoining Property: Authority for performing indicated removal and alteration Work on property adjoining Owner's property shall be obtained by the adjoining property Owner(s) prior to commencement of Work.
- F. Protect existing Work and Work of other trades: Damage to existing construction caused by Work of this Section shall be promptly repaired and/or replaced at the expense of the Contractor.
- G. Environmental Requirements: Perform actual pruning operations (if needed) during those seasons suitable for the specific tree type, in accordance with locally acceptable horticultural practices.
- H. No activities are to occur or practices are prohibited within protection zones. The following practices are as and not limited to as follows:
 - 1. Storage of construction materials, tools, fuel, lubricants, chemicals, paints, solvents, 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 digging unless otherwise indicated.
 - 7. Attachment of signs to or wrapping materials around trees unless otherwise indicated.
- I. Do not direct vehicle or equipment exhaust toward protection zones.
- J. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

1.9 SCHEDULE

- A. Identify suitable trees for timber salvage.

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- B. Install Tree Protection Barricades prior to commencement of Work.
 - C. Work shall be done according to approved Schedule.

1.10 GUARANTEE

- A. Contractor shall Guarantee that plants covered under the Provisions of this Section shall be healthy and in a flourishing condition of active growth for two (2) years from the date of Final Acceptance.
- B. Requirements of the guarantee shall apply if failure of the Contractor to take specified precautions and Work within restrictions of this Section contributes to the destruction, decline, or injury to a tree to remain, in the judgment of the Landscape Architect.
- C. If a tree designated to be protected accordingly is destroyed or injured so that in the judgment of the Landscape Architect it should be replaced, it shall be removed at the expense of the Contractor. Contract shall pay compensation to the Owner of the property where the tree was located at the rate as specified herein this Section (see Compensation).

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:
 - 1. Type: Hardwood and bark chips
 - 2. Size Range: 3 inches - 1/2 inch.
 - 3. Color: Natural.
- B. Protection-Zone Fencing: Fencing fixed in position and meeting the following requirements.
 - 1. Chain-Link Protection-Zone Fencing: Galvanized-steel fencing fabricated from minimum 2-inch (50-mm) opening, 0.148-inch- (3.76-mm-) diameter wire chain-link fabric; with pipe posts, minimum 2-3/8-inch- (60-mm-) OD line posts, and 2-7/8-inch- (73-mm-) OD corner and pull posts; with 1-5/8-inch- (42-mm-) OD top rails with 0.177-inch- (4.5-mm-) diameter top tension wire] and 0.177-inch- (4.5-mm-) diameter bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system.
 - a. Height: 6 feet (1.8 m).
 - 2. Gates: Single swing access gates matching material and appearance of fencing, to allow for maintenance activities within protection zones; leaf width 36 inches (914 mm).
- C. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes pre punched and reinforced; legibly printed with nonfading lettering and as follows:
 - 1. Size and Text: 24x26-inches, TREE PROTECTION ZONE. Keep Clear at all Times; PROTECCION DE ARBOLES. Mantente alejado de todos los Tiempos.

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2. Lettering: 3-inch (English) 1 1/2-inch (Spanish)- (75-mm high minimum, black characters on orange background).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place (SWPPP). Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- B. For the record, prepare written report, endorsed by arborist, listing conditions detrimental to tree and plant protection per Section 1.
- C. Protect existing site improvements to remain from damage during construction.

3.2 PREPARATION

- A. Locate and clearly identify trees, shrubs, and other vegetation to remain. Attached a tamper proof sequentially numbered metal or plastic tag and blue-vinyl flagging ribbon tape around each tree trunk at 48 inches (1200 mm) above the ground.
- B. Locate and clearly identify trees, shrubs, and other vegetation to be removed and salvaged for timber. Attached a tamper proof sequentially numbered metal or plastic tag and vinyl flagging ribbon tape around each tree trunk at 48 inches (1200 mm) above the ground.
 1. Trees to be removed and mulched: Orange flagging ribbon.
 2. Trees to be removed and salvaged for timber: Blue and white striped flagging ribbon
- C. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.
- D. Locate and clearly stake mulch stockpile and timber salvages areas.
- E. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas indicated.
 1. Apply 2-inch (75-mm)] average thickness of organic mulch. Do not place mulch within 6 inches (150 mm) of tree trunks.

3.3 TREE- AND PLANT-PROTECTION ZONES

- A. Protect existing trees and other vegetation indicated to remain in place against the following:
 1. Storage or parking of automobiles or other vehicles.
 2. Stockpiling of building materials, refuse, or excavated materials.
 3. Use of trees as support posts, power posts, or sign posts, anchorage for ropes, guy wires, or power lines, or other similar functions.

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4. Dumping of poisonous materials on or around plant roots, trunks, branches, or foliage. Such materials include, but are not limited to, paint, petroleum products, dirty water, or other deleterious materials.
 5. Cutting, breaking, or shinning of roots caused by utility trenching, foundation digging, placement of curbs and trenches, and other miscellaneous excavation without prior written approval by the Landscape Architect.
 6. Damage by skinning or bruising of bark on trunks or branches, caused by maneuvering vehicles or stacking material or equipment too close to the plant.
 7. Compaction of the soil within the drip-line of the plants due to movement of trucks or grading machines, pedestrian or vehicular traffic, storage of equipment or materials.
 8. Excessive water or heat from equipment, utility line construction, or burning of trash under or near vegetation to remain.
 9. Damage to root system from flooding, erosion, and excessive wetting and drying resulting from watering and other operations.
- B. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people and animals from easily entering protected area except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.
1. Chain-Link Fencing: Install to comply with ASTM F 567 and with manufacturer's written instructions.
 2. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to Architect.
 3. Access Gates: Install where indicated on shop drawings, adjust to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- C. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by Architect. Install one sign spaced approximately every 20 feet (6m) on protection-zone fencing, but no fewer than two signs per TPZ with each facing a different direction.
- D. Maintain protection zones free of weeds and trash.
- E. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.
- F. Maintain protection-zone fencing and signage in good condition as acceptable to Architect and remove when construction operations are complete, and equipment has been removed from the site.
1. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
 2. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

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- G. Irrigation: Contractor shall supply fresh potable water in adequate amounts and rates of application as required to maintain the health of protected plant material throughout the duration of the construction operations. Contractor shall maintain a watering schedule and document dates and duration of irrigation applications.
1. Construct a temporary watering basin, as required, on the surface of the existing undisturbed grade, with imported soil, to aid in the retention of water around existing protected trees and planting.

3.4 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.
1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
 3. Completely remove stumps, roots, obstructions, and debris extending to a depth of eighteen-inches (18") inches below exposed sub-grade.
 4. Use only hand methods for grubbing within drip line of remaining trees.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated.

3.5 EXCAVATION

- A. General: Excavate at edge of protection zones and for trenches indicated within protection zones according to requirements in Section 31000 "Site Earthwork."
- B. Trenching near Trees: Where utility trenches are required within protection zones, hand excavate under or around tree roots or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning. All work within tree protection zones to be done under supervision of the project arborist or Landscape Architect.
- C. Redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches (75 mm) back from new construction and as required for root pruning.
- D. 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.

3.6 ROOT PRUNING

- A. Prune roots that are affected by temporary and permanent construction. Prune roots as shown on Shop Drawings and as follows:
 - 1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
 - 2. Cut Ends: Do not paint cut root ends.
 - 3. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
 - 4. Cover exposed roots with burlap and water regularly.
 - 5. Backfill as soon as possible according to requirements in Section 312000 "Earth Moving."
- B. Root Pruning at Edge of Protection Zone: 6 inches (150 mm) inside flush with the edge of the protection zone, by cleanly cutting all roots to the depth of the required excavation.
- C. Root Pruning within Protection Zone: Clear and excavate by hand to the depth of the required excavation to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

3.7 CROWN PRUNING

- A. Prune branches that are affected by temporary and permanent construction. Prune branches as follows:
 - 1. Prune trees to remain to compensate for root loss caused by damaging or cutting root system. Provide subsequent maintenance during Contract period as recommended by arborist.
 - 2. Pruning Standards: Prune trees according to ANSI A300 (Part 1).
 - 3. Cut branches with sharp pruning instruments; do not break or chop.
 - 4. Do not apply pruning paint to wounds.
 - 5. Tie up branches that are required to remain but extend beyond the tree- or plant-protection zone.

3.8 REGRADING

- A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
- B. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

3.9 FIELD QUALITY CONTROL

- A. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.
- B. Keep areas within tree protection barricades free from weeds, trash, and debris. Do not use herbicides.

3.10 STOCKPILE

- A. Keep stockpile and storage areas free from weeds, trash, and debris. Do not use herbicides.
- B. Turn over mulch stockpile on a bi weekly basis and or if it begins emit foul odors.
- C. Store timber on wood skids, logs or heavy mulch layer as feasible.
- D. Maintain mulch layer and protective devices throughout entire duration of Contract.

3.11 REPAIR AND REPLACEMENT

- A. General: Repair or replace trees indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.
 - 1. Submit details of proposed root cutting and tree and shrub repairs.
 - 2. Have arborist perform the root cutting, branch pruning, and damage repair of trees and shrubs.
 - 3. Treat damaged trunks, limbs, and roots according to arborist's written instructions.
 - 4. Perform repairs within 24 hours.
 - 5. Replace vegetation that cannot be repaired and restored to full-growth status, as determined by Architect.
- B. Trees: Remove and replace trees indicated to remain that are more than 35 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.
 - 1. Provide new trees of same species as those being replaced for each tree that measures 6 inches – 12-inches in caliper size.
 - 2. Provide two new tree(s) of 8-inch (150-mm) caliper size for each tree being replaced that measures more than 12 inches (300 mm in caliper size).
 - a. Species: Species selected by Architect.
 - 3. Plant and maintain new trees as specified in Section 329300 "Plants."
- C. Soil Aeration: Where directed by Architect, aerate surface soil compacted during construction. Aerate 10 feet (3 m)] beyond drip line and no closer than 36 inches (900 mm) to tree trunk. Drill 2-inch- (50-mm) diameter holes a minimum of 12 inches (300 mm) deep at 24 inches (600 mm) o.c. Backfill holes with an equal mix of augured soil and sand.

3.12 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove excess excavated material, displaced trees, trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 015639

PART 1 - GENERAL

1.1 DEFINITIONS

- A. A/E, Architect, Engineer of Record – The licensed design professional applying stamp and signature to the drawings regardless of their contractual relationship to the Owner.
- B. BMP – Best Management Practices.
- C. Contractor – Firm responsible for providing prime construction services for the project under contract with the Owner. Refers to the General Contractor, Prime Contractor, Construction Manager at Risk or Design Build firm under various contract types.
- D. CSN –Construction Site Notice.
- E. NOI &NOT – Notice of Intent and Notice of Termination for TPDES permits.
- F. SWPPP – Storm Water Pollution Prevention Plan.
- G. TCEQ – Texas Commission on Environmental Quality.
- H. TPDES – Texas Pollutant Discharge Elimination System.
- I. Large Construction Activities – Construction activities including clearing, grading and excavating that result in land disturbance of equal to or greater than five (5) acres.
- J. Small Construction Activities - Construction activities including clearing, grading and excavating that result in land disturbance of equal to or greater than one (1) acre and less than five (5) acres of land.

1.2 RELATED DOCUMENTS AND APPLICABLE WORK

- A. The TCEQ TPDES General Permit No. TXR150000, March 15, 2018, amended January 28, 2022 and the project SWPPP. This specification requires compliance with all provisions of the TCEQ with regards to the TPDES permit. The TCEQ requirements currently pertain to large construction activities of five (5) acres or more and small construction activities which disturb one (1) to less than five (5) acres.
- B. Information to Respondents, Agreement, Uniform General Conditions, Supplementary General Conditions and Special Conditions shall be carefully read for provisions pertaining to this work. In the event of conflict, the better quality or greater quantity shall prevail.
- C. The work described in this section is applicable to any and all sections of the Contract Documents. Any and all work that would disturb the existing site conditions or present the potential for site runoff shall adhere fully to this specification section.
- D. Unless specifically notified to the contrary by the Owner, in writing, all aspects of this specification shall apply to this project.

1.3 CONTRACTOR RESPONSIBILITIES

- A. This project requires implementation of storm water “Best Management Practices” (BMP) for control devices and monitoring by the Contractor to comply with all provisions of the Storm Water Pollution Prevention Plan (SWPPP) developed for the project by the licensed civil engineer. The Contractor must fulfill all Texas Pollutant Discharge Elimination System (TPDES) regulatory requirements, including the filing of a NOI and NOT or signing and posting of the Construction Site Notice (CSN).
- B. The Contractor shall provide signatures of a corporate Officer for the NOI, CSN and NOT and any other forms or applications as required by the TPDES General Permit TXR150000. The Contractor shall also provide delegated authorization to sign reports per 30 TAC 305.128. Individuals conducting site inspections shall be qualified to the satisfaction of the Owner. Documented qualifications shall be included in the SWPPP booklet.
- C. When the Contractor receives the approved SWPPP from the Owner, the Contractor signs the NOI or CSN (see Sample form in Part 4 of this section) and forwards it to the Owner. A \$100 application fee must accompany the NOI. The Owner signs his NOI and sends both NOI’s and application fees to TCEQ. The Contractor shall insert a copy of the signed NOI or CSN into the SWPPP booklet to be kept at the jobsite.
- D. The SWPPP booklet kept at the jobsite shall also contain the following:

1. A letter delegating signature authority to the field personnel for both the Contractor and the Owner.
 2. A copy of TPDES permit when received.
 3. Posting Notice for large construction activities.
- E. The Contractor shall review SWPPP and verify existing conditions at the site before determining scope of implementation of site controls. Site survey and site plan drawings shall be used for additional reference. The Contractor shall notify the Owner, in advance, of this site review to allow for Owner participation.
- F. The Contractor shall construct a Project SWPPP sign and place it at the main entrance to the project site. This sign shall include the NOI and TPDES permit; or the Construction Site Notice for small construction projects. The sign shall be constructed as detailed in the sample SWPPP sign drawing included in Part 4 of this Section.
- G. Contractor shall contact Owners Representative for review of initial site controls in place prior to commencing site-disturbing activities, to ensure that any unusual circumstances or unforeseen site conditions with regard to erosion and sedimentation have been addressed.
- H. The Contractor shall provide all material, labor, equipment and services required to implement, maintain and monitor all erosion and sedimentation controls in compliance with the Storm Water Pollution Prevention Plan (SWPPP). All controls implemented by the Contractor shall comply with the Texas Pollutant Discharge Elimination System (TPDES) regulations as issued by the Texas Commission on Environmental Quality (TCEQ) on February 19, 2013. These controls shall remain in operation until project completion and reestablishment of the site or longer as directed by the Owners Representative. The work shall include, but not be limited to the following:
1. All earthwork as required to implement swales, dikes, basins and other excavations for temporary routing of utilities, to protect against erosion or sediment-laden ("polluted") storm water runoff.
 2. All structural controls as shown or specified, including silt fences, sediment traps, stabilized construction entrance, subsurface drains, pipe slope drains, inlet/outlet protection, reinforced soil retention, gabions, rock berms, etc.
 3. All non-structural controls as shown or specified, including temporary or permanent vegetation, mulching, geotextiles, sod stabilization, preservation of vegetative buffer strips, preservation/protection of existing trees and other mature vegetation.
 4. All modifications and revisions to SWPPP necessary to meet changing site conditions, and to address new sources of storm water discharges, as the work progresses.
 5. All maintenance and repair of structural and non-structural controls in place shall continue until final stabilization is achieved or as directed by the Owners Representative.
 6. Weekly site inspections, as required by the SWPPP, of pollutant sources, including hazardous sources, structural and non-structural controls, and all monitoring of SWPPP revisions and maintenance of inspection records.
 7. Removal of all structural and non-structural controls as necessary upon completion, and only after final stabilization is achieved.
 8. Filing of Notice of Termination (NOT) with the Owners Representative within 30 days of final stabilization being achieved, or of another Operator assuming control of the unstabilized portions of the site.
- I. Refer to the SWPPP for additional requirements to ensure compliance with TPDES regulations.

1.4 QUALITY ASSURANCE

- A. In order to minimize the discharge of pollutants to storm water, the Contractor shall implement all permanent and temporary site controls according to Texas Pollutant Discharge Elimination System (TPDES) Guidelines, as set forth by the Texas Commission on Environmental Quality.
- B. Implementation of site controls shall be performed by a qualified contractor experienced in the proper installation of such devices in accordance with manufacturers' specifications, and in keeping with recognized Best Management Practices (BMP's), and in keeping with TPDES regulations.

Qualification of installing Contractor shall be reviewed with the Owner prior to entering into a contract with them for services.

- C. The Contractor shall inspect all BMP's at regular intervals as specified in the Storm Water Pollution Prevention Plan for this project. Record all deficiencies of site controls, and take immediate action to correct any deficiencies recorded. Keep records of inspections current and on file, available for review by EPA, TCEQ, MS4 operator and Owner.

1.5 SUBMITTALS

- A. Submittals of products used in structural and non-structural controls shall be made through established procedures for review and approved by the Engineer of Record prior to installation on the site. The Contractor shall make available physical samples and product literature on any material used in structural or non-structural controls during the course of the project prior to its implementation in the field.

PART 2 - PRODUCTS

2.1 TEMPORARY EROSION CONTROL

- A. In all cases, the development of plans and specifications will give first consideration to erosion controls, as it is much easier to maintain soil cover than to trap sediment. The goal of the planned erosion control will be to divert runoff away from unstable areas or to provide a stable surface that will resist the effects of rain and runoff. All projects should utilize one or more of the following practices unless engineer ascertains that there is no chance of runoff entering the project from areas adjoining the site. The preferred erosion controls to be used on the project include:
 1. Interceptor swale - use as perimeter control, less than 5 acres only.
 2. Diversion dike – use to route runoff away from project site, less than 10 acres only. Pipe slope drain – transport runoff down steep, erodible slopes, less than 5 acres only.
 3. Outlet stabilization – prevent erosion at outlet of channel or conduit.
 4. Level spreader – outlet device for dikes and diversions.
 5. Subsurface drain – use to prevent soils from becoming saturated and prevent seeps.
 6. Tree protection – for erosion control and aesthetics.
 7. Temporary vegetation – RECOMMENDED - use for temporary stabilization of disturbed areas; for slopes steeper than 3:1 use in conjunction with matting.
 8. Blankets/matting – use in channels and on steep slopes.
 9. Mulch – use to stabilize newly seeded areas.
 10. Sod – use for immediate stabilization of channels, around inlets.
 11. Dust Control – use in areas subject to air movement of dust.

2.2 TEMPORARY SEDIMENT CONTROL

- A. Activities at most sites will result in soil disturbance. Erosion will occur in the disturbed areas and best management practices must be planned to contain and sediment transported by runoff. The preferred erosion controls to be used on the project include:
 1. Test. Construction exit – use at all designated access points.
 2. Silt fence (interior) – useful in areas of minor sheet flow, use 100 ft. or more of fence for each ¼ acre.
 3. Silt fence (exterior) – use along down slope borders of site, use 100 ft. or more of fence for each ¼ acre.
 4. Triangular filter dikes – use for areas within site requiring frequent access (movable).
 5. Hay bale dike – use in areas of minor sheet flow, use 100 ft. or more for each ¼ acre – Note: replace every 3 months.
 6. Rock berm – use for drainage swales and ditches within and below site, less than 5 acres.
 7. High service rock berm – use around sensitive features and in high flow areas within and below site, less than 5 acres.

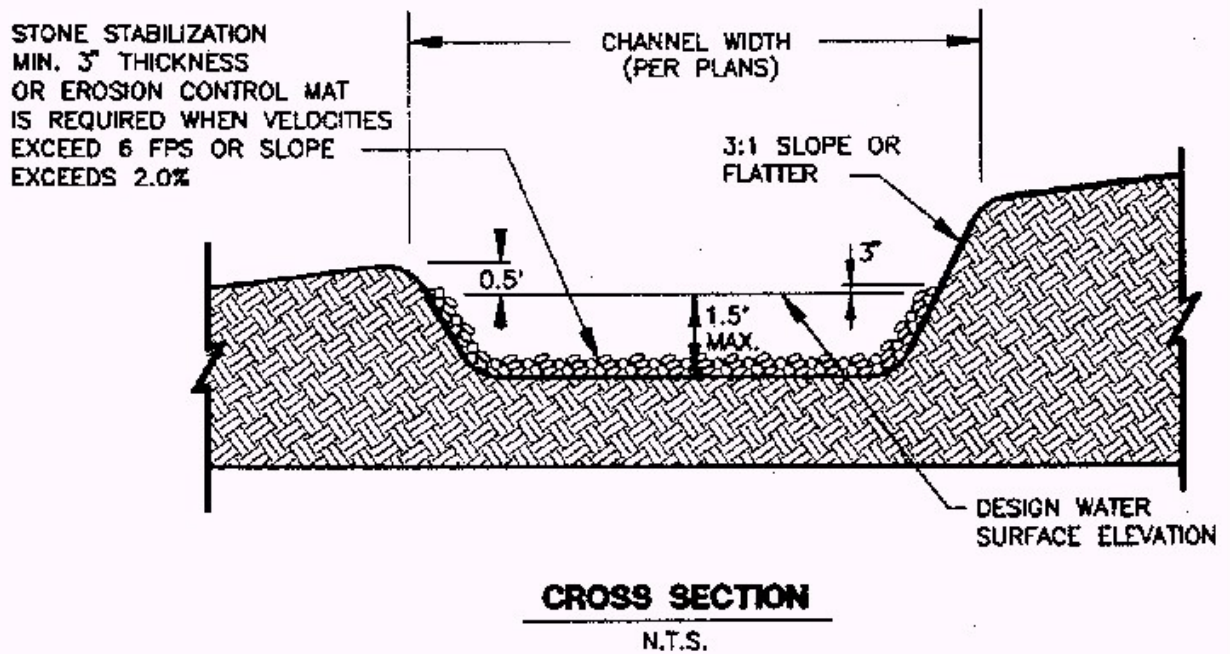
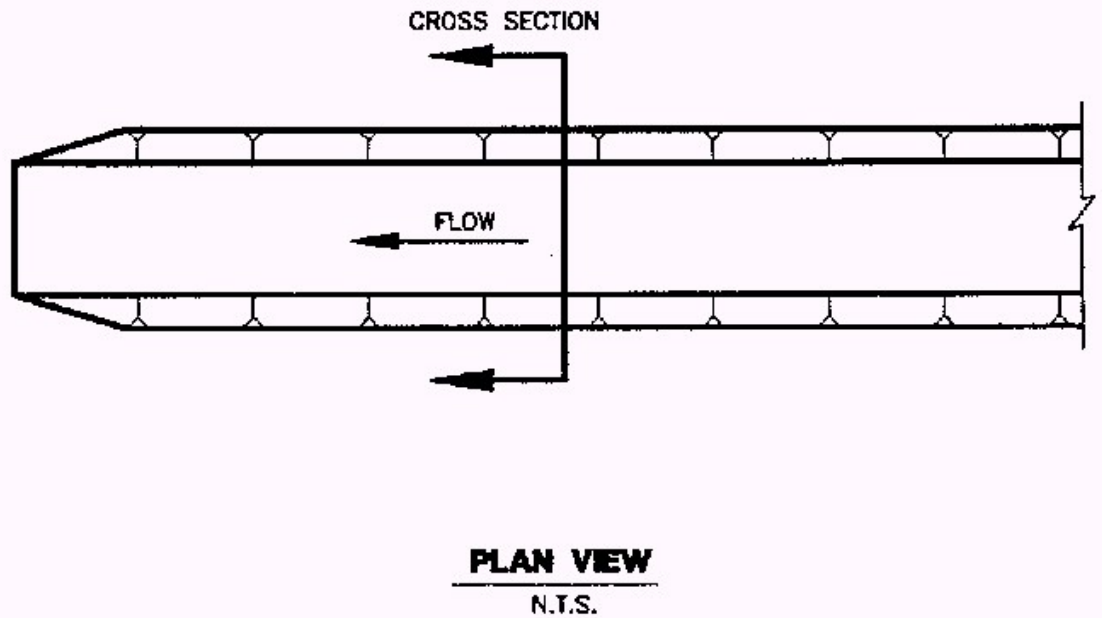
8. Brush berm – use in small areas of sheet flow, less than 2 acres.
9. Sand bag berm – use for construction in streambeds, contributing drainage area 5 – 10 acres.
10. Buffer (vegetative) strips – use on floodplains, next to wetlands, along stream banks, and on steep slopes.
11. Inlet protection – prevent sediment from entering storm inlet, less than 1 acre.
12. Sediment trap – use where flows are concentrated in a swale of channel, 1 - 5 acres.
13. Sediment basin – use for larger disturbed areas, 5 – 100 acres.

PART 3 - EXECUTION

3.1 EROSION CONTROLS

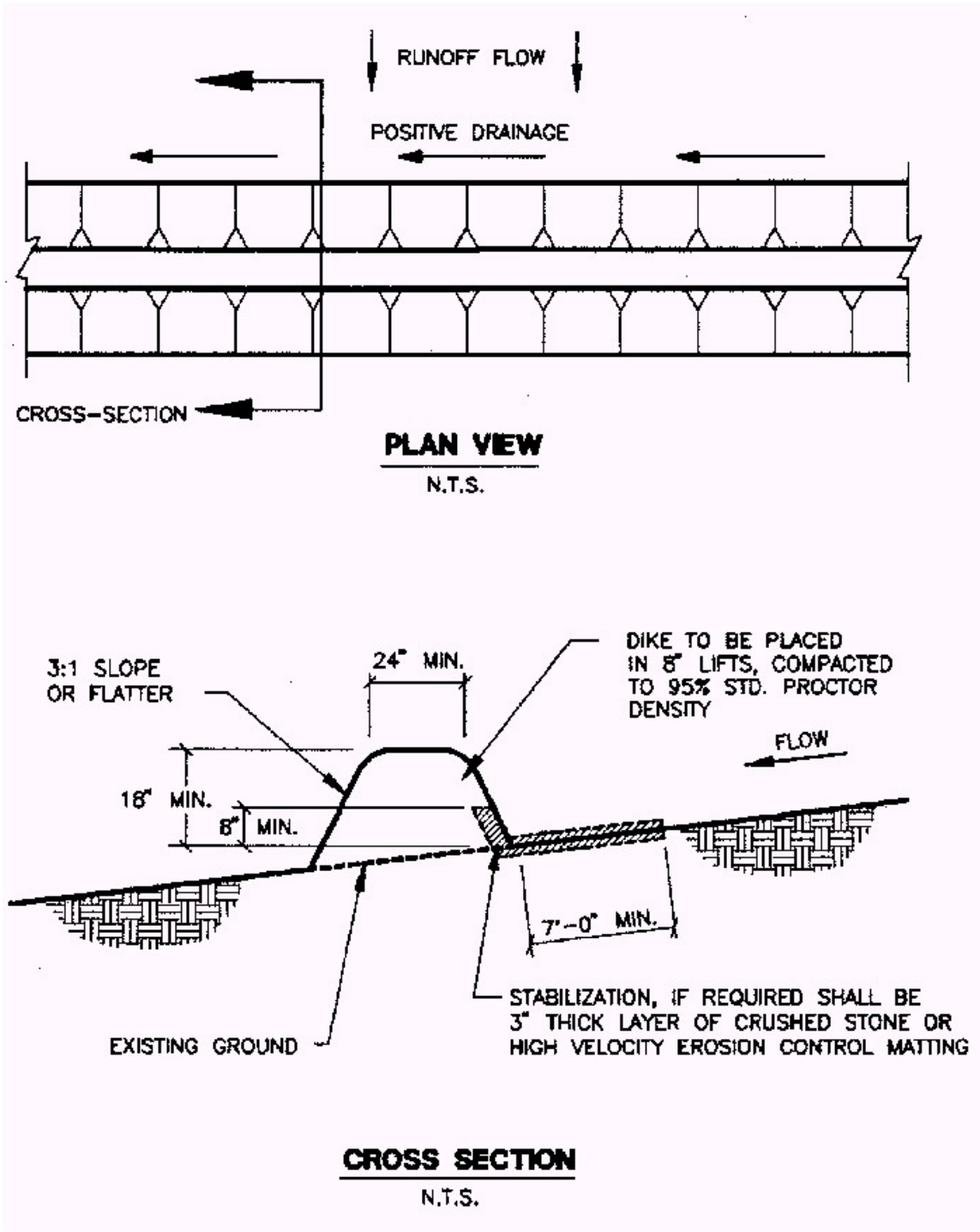
A. Interceptor Swales.

1. Interceptor swales are used to shorten the length of exposed slope by intercepting runoff and can also serve as perimeter swales preventing off-site runoff from entering the disturbed area or prevent sediment-laden runoff from leaving the construction site or disturbed area. They may have a V-shape or be trapezoidal with a flat bottom and side slopes of 3:1 or flatter. The outflow from a swale should be directed to a stabilized outlet or sediment-trapping device. The swales should remain in place until the disturbed area is permanently stabilized. A schematic of an interceptor swale is shown below.
2. Materials:
 - a. Stone stabilization should be used when grades exceed 2% or velocities exceed 6 feet per second and should consist of a layer of crushed stone three inches thick, riprap or high velocity erosion control mats.
 - b. Stabilization should extend across the bottom of the swale and up both sides of the channel to minimum height of three inches above the design water surface elevation based on a 2-year, 24-hour storm.
3. Installation:
 - a. An interceptor swale should be installed across exposed slopes during construction and should intercept no more than 5 acres of runoff.
 - b. All earth removed and not needed in construction should be disposed of in an approved spoils site so that it will not interfere with the functioning of the swale or contribute to siltation in other areas of the site.
 - c. Trees, brush, stumps, obstructions and other material should be removed and disposed of to avoid interference with proper functioning of the swale.
 - d. Should have a maximum depth of 1.5 feet with side slopes of 3:1 or flatter. Swale should have positive drainage for its entire length to an outlet.
 - e. When the slope exceeds 2 percent, or velocities exceed 6 feet per second (regardless of slope), stabilization is required. Stabilization should be crushed stone placed in a layer of at least 3 inches thick or may be high velocity erosion control matting. Check dams are also recommended to reduce velocities in the swales possibly reducing the amount of stabilization necessary.
 - f. Minimum compaction for the swale should be 90% standard proctor density.
4. Inspection and Maintenance Guidelines:
 - a. Swales should be inspected weekly and after each rain event to locate and repair any damage to the channel or clear debris or other obstructions so as not to diminish flow capacity.
 - b. Damage from storms or normal construction activities such as tire ruts or disturbance of swale stabilization should be repaired as soon as practical.
5. Schematic Diagram of an Interceptor Swale:



B. Diversion Dikes.

1. A temporary diversion dike is a barrier created by the placement of an earthen embankment to reroute the flow of runoff to an erosion control device or away from an open, easily erodible area. A diversion dike intercepts runoff from small upland areas and diverts it away from exposed slopes to a stabilized outlet, such as a rock berm, sandbag berm, or stone outlet structure. These controls can be used on the perimeter of the site to prevent runoff from entering the construction area. Dikes are generally used for the duration of construction to intercept and reroute runoff from disturbed areas to prevent excessive erosion until permanent drainage features are installed and/or slopes are stabilized. A schematic of a diversion dike is shown below.
2. Materials:
 - a. Stone stabilization (required for velocities in excess of 6 fps) should consist of riprap placed in a layer at least 3 inches thick and should extend a minimum height of 3 inches above the design water surface up the existing slope and the upstream face of the dike.
 - b. Geotextile fabric should be a non-woven polypropylene fabric designed specifically for use as a soil filtration media with an approximate weight of 6 oz./yd², a Mullen burst rating of 140 psi, and having an equivalent opening size (EOS) greater than a #50 sieve.
3. Installation:
 - a. Diversion dikes should be installed prior to and maintained for the duration of construction and should intercept no more than 10 acres of runoff.
 - b. Dikes should have a minimum top width of 2 feet and a minimum height of compacted fill of 18 inches measured from the top of the existing ground at the upslope toe to top of the dike and having side slopes of 3:1 or flatter.
 - c. The soil for the dike should be placed in lifts of 8 inches or less and be compacted to 95 % standard proctor density.
 - d. The channel, which is formed by the dike, must have positive drainage for its entire length to an outlet.
 - e. When the slope exceeds 2 percent, or velocities exceed 6 feet per second (regardless of slope), stabilization is required. Situations in which velocities do not exceed 6 feet per second, vegetation may be used to control erosion.
4. Inspection and Maintenance Guidelines:
 - a. Swales should be inspected weekly and after each rain event to determine if silt is building up behind the dike or if erosion is occurring on the face of the dike. Locate and repair any damage to the channel or clear debris or other obstructions so as not to diminish flow capacity.
 - b. Silt should be removed in a timely manner.
 - c. If erosion is occurring on the face of the dike, the slopes of the face should either be stabilized through mulch or seeding or the slopes of the face should be reduced.
 - d. Damage from storms or normal construction activities such as tire ruts or disturbance of swale stabilization should be repaired as soon as practical.
5. Schematic Diagram of a Diversion Dike (NCTOG, 1993b):

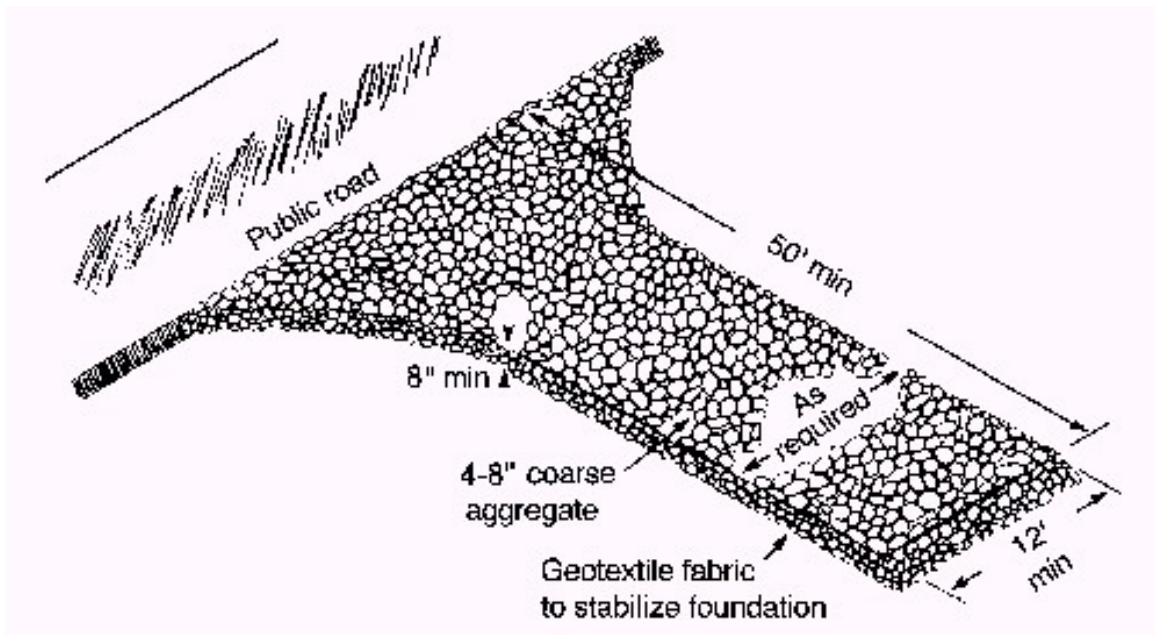


3.2 SEDIMENT CONTROLS

A. Temporary Construction Entrance/Exit.

1. The purpose of a temporary construction entrance is to provide a stable entrance/exit condition from the construction site and keep mud and sediment off public roads. A stabilized construction entrance is a stabilized pad of crushed stone located at any point traffic will be entering or leaving the construction site from a public right-of-way, street, alley, sidewalk or parking area. The purpose of a stabilized construction entrance is to reduce or eliminate the tracking or flowing of sediment onto public rights-of-way. This practice should be used at all points of construction ingress and egress. Excessive amounts of mud can also present a safety hazard to roadway users. To minimize the amount of sediment loss to nearby roads, access to the construction site should be limited to as few points as possible and vegetation around the perimeter should be protected where access is not necessary. A rock stabilized construction entrance should be used at all designated access points.
2. Materials:
 - a. The aggregate should consist of 4 to 8 inch washed stone over a stable foundation as specified in the plan.
 - b. The aggregate should be placed with a minimum thickness of 8 inches.
 - c. The geotextile fabric should be designed specifically for use as a soil filtration media with an approximate weight of 6 oz./yd², a mullen burst rating of 140 lb/in², and an equivalent opening size greater than a number 50 sieve.
 - d. If a washing facility is required, a level area with a minimum of 4 inch washed stone or commercial rack should be included in the plans. Divert wastewater to a sediment trap or basin.
3. Installation:
 - a. Avoid curves on public roads and steep slopes. Remove vegetation and other objectionable material from the foundation area. Grade crown foundation for positive drainage.
 - b. The minimum width of the entrance/exit should be 12 feet or the full width of exit roadway, whichever is greater.
 - c. The construction entrance should be at least 50 feet long.
 - d. If the slope toward the road exceeds 2%, construct a ridge, 6 to 8 inches high with 3:1 (H:V) side slopes, across the foundation approximately 15 feet from the entrance to divert runoff away from the public road.
 - e. Place geotextile fabric and grade foundation to improve stability, especially where wet conditions are anticipated.
 - f. Place stone to dimensions and grade shown on plans. Leave surface smooth and slope for drainage.
 - g. Divert all surface runoff and drainage from the stone pad to a sediment trap or basin.
 - h. Install pipe under pad as needed to maintain proper public road drainage.
4. Common Trouble Points:
 - a. Inadequate runoff control – sediment washes onto public road.
 - b. Stone too small or geotextile fabric absent, results in muddy condition as stone is pressed into soil.
 - c. Pad too short for heavy construction traffic – extend pad beyond the minimum 50 foot length as necessary.
 - d. Pad not flared sufficiently at road surface, results in mud being tracked on to road and possible damage to road edge.
 - e. Unstable foundation – use geotextile fabric under pad and/or improve foundation drainage.
5. Inspection and Maintenance Guidelines:
 - a. The entrance should be maintained in a condition, which will prevent tracking or flowing of sediment onto public rights-of-way. This may require periodic top dressing with additional

- stone as conditions demand and repair and/or cleanout of any measures used to trap sediment.
- b. All sediment spilled, dropped, washed or tracked on to public rights-of-way should be removed immediately by contractor.
 - c. When necessary, wheels should be cleaned to remove sediment prior to entrance onto public right-of-way.
 - d. When washing is required, it should be done on an area stabilized with crushed stone that drains into an approved sediment trap or sediment basin.
 - e. All sediment should be prevented from entering any storm drain, ditch or water course by using approved methods.
6. Schematic Diagram of a Temporary Construction Entrance/Exit (after NC, 1993):



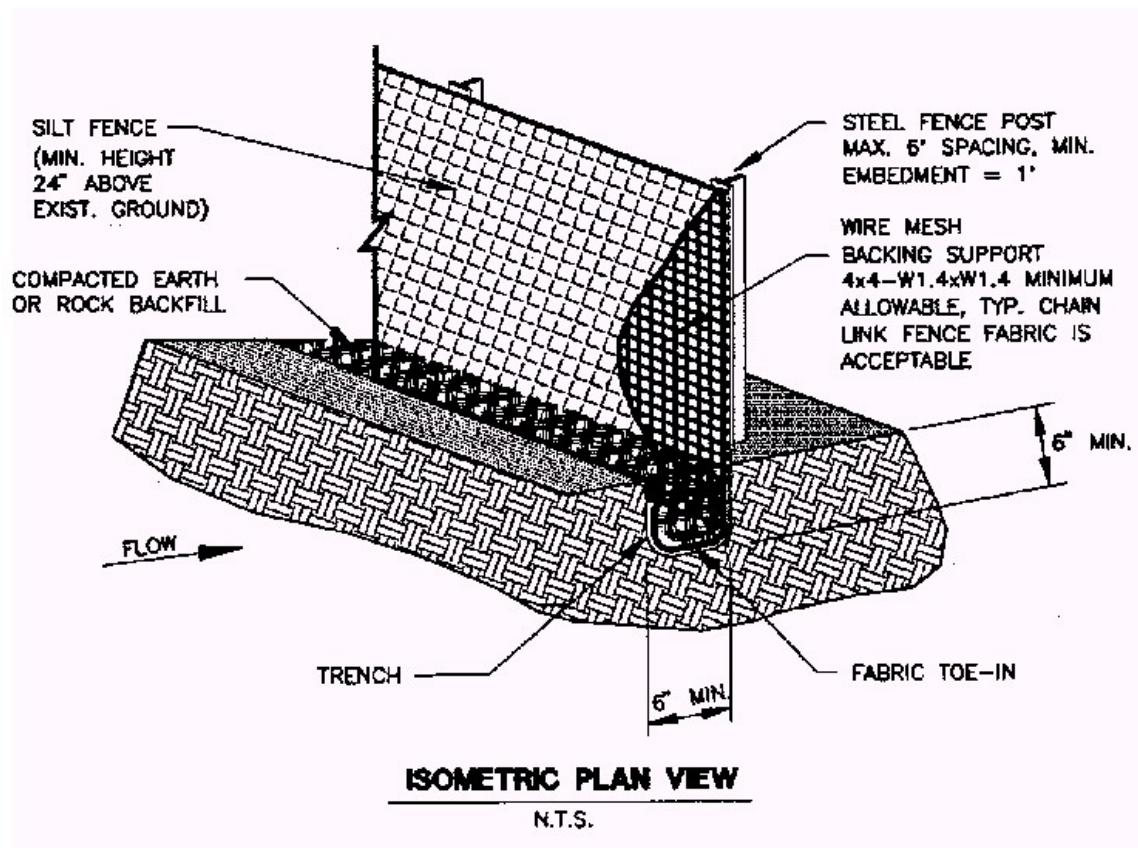
B. Silt Fence.

1. A silt fence is a barrier consisting of geotextile fabric supported by metal posts to prevent soil and sediment loss from a site. When properly used, silt fences can be highly effective at controlling sediment from disturbed areas. They cause runoff to pond, allowing heavier solids to settle out. If not properly installed, silt fences are not likely to be effective.
2. The purpose of a silt fence is to intercept and detain water-borne sediment from unprotected areas of a limited extent. Silt fence is used during the period of construction near the perimeter of a disturbed area to intercept sediment while allowing water to percolate through. This fence should remain in place until the disturbed area is permanently stabilized. Silt fence should not be used where there is a concentration of water in a channel or drainage way. If concentrated flow occurs after installation, corrective action must be taken such as placing a rock berm in the areas of concentrated flow. Silt fencing within the site may be temporarily moved during the day to allow construction activity provided it is replaced and properly anchored to the ground at the end of the day. Silt fences on the perimeter of the site or around drainage ways should not be moved at any time.
3. Materials:
 - a. Filter Fabric:
 - 1) General: The filter fabric shall be of non-woven polypropylene, polyethylene or polyamide thermoplastic fibers with non-raveling edges. The fabric shall be non-biodegradable, inert to most soil chemicals, ultraviolet resistant, unaffected by moisture or other weather conditions, and permeable to water while retaining sediment. The filter fabric shall be supplied in rolls a minimum of 36 inches wide.
 - 2) Physical Requirements: The fabric shall meet the following requirements when sampled and tested in accordance with the methods indicated:

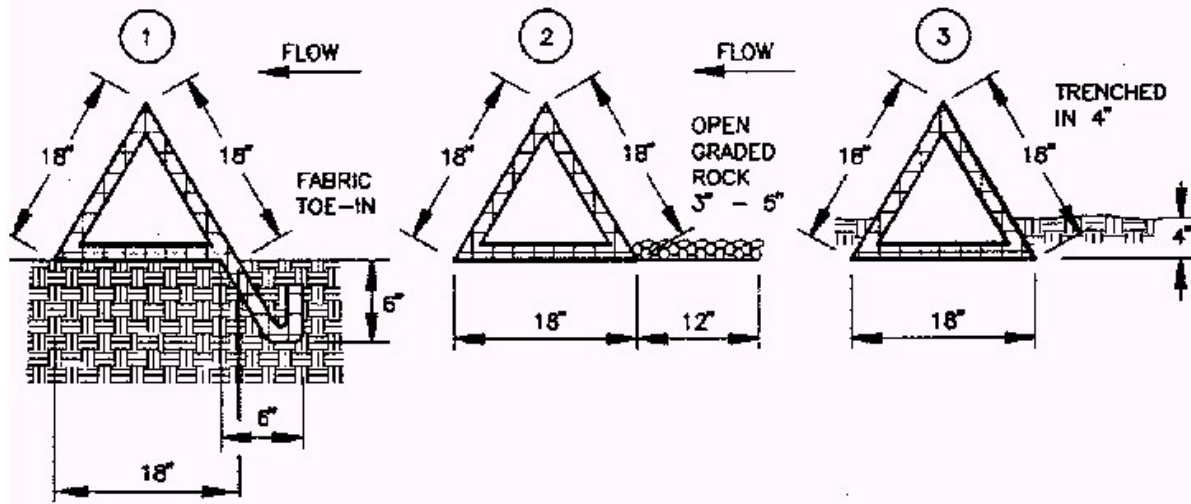
PHYSICAL PROPERTIES	METHOD	REQUIREMENTS
Fabric Weight (oz/sy)	ASTM D3776	4.5 minimum
Water Flow Rate (gal/sq ft/min)	ASTM D4491	40 maximum
Equivalent Opening Size	ASTM D4751	20 - 100
Grab Tensile (lbs)	ASTM D4632	100 minimum
Millen Burst Strength (psi)	ASTM D3786	300 minimum
Ultraviolet Resistance	ASTM D1682	70 minimum
Trapezoid Tear (lbs)	ASTM D4533	55 minimum
Elongation (%)	ASTM D4632	30 maximum

- b. Fence Posts: Posts shall be painted or galvanized steel Tee or Y Posts with anchor plates, not less than 5 feet in length with a minimum weight of 1.3 pounds per foot with a minimum Brinell Hardness of 143. Hangers shall be adequate to secure fence and fabric to posts. Posts and anchor plates shall conform to ASTM A702.
- c. Woven Wire shall be welded wire fabric 2x4-W1.0 x W 1.0.
4. Installation:
 - a. Steel posts, which support the silt fence, should be installed on a slight angle toward the anticipated runoff source. Post must be embedded a minimum of 1 foot deep and spaced not more than 8 feet on center. Where water concentrates, the maximum spacing should be 6 feet.
 - b. Lay out fencing down-slope of disturbed area, following the contour as closely as possible. The fence should be sited so that the maximum drainage area is ¼ acre/100 feet of fence.
 - c. The toe of the silt fence should be trenched in with a spade or mechanical trencher, so that the down-slope face of the trench is flat and perpendicular to the line of flow. Where fence

- cannot be trenched in (e.g., pavement or rock outcrop), weight fabric flap with 3 inches of pea gravel on uphill side to prevent flow from seeping under fence.
- d. The trench must be a minimum of 6 inches deep and 6 inches wide to allow for the silt fence fabric to be laid in the ground and backfilled with compacted material.
 - e. Silt fence should be securely fastened to each steel support post or to woven wire, which is in turn attached to the steel fence post. There should be a 3-foot overlap, securely fastened where ends of fabric meet.
 - f. Silt fence should be removed when the site is completely stabilized so as not to block or impede storm flow or drainage.
5. Common Trouble Points:
 - a. Fence not installed along the contour causing water to concentrate and flow over the fence.
 - b. Fabric not seated securely to ground (runoff passing under fence).
 - c. Fence not installed perpendicular to flow line (runoff escaping around sides).
 - d. Fence treating too large an area, or excessive channel flow (runoff overtops or collapses fence).
 6. Inspection and Maintenance Guidelines:
 - a. Inspect all fencing weekly, and after any rainfall.
 - b. Remove sediment when buildup reaches 6 inches, or install a second line of fencing parallel to the old fence.
 - c. Replace any torn fabric or install a second line of fencing parallel to the torn section.
 - d. Replace or repair any sections crushed or collapsed in the course of construction activity. If a section of fence is obstructing vehicular access, consider relocating it to a spot where it will provide equal protection, but will not obstruct vehicles. A triangular filter dike may be preferable to a silt fence at common vehicle access points.
 7. Schematic Diagram of a Silt Fence:



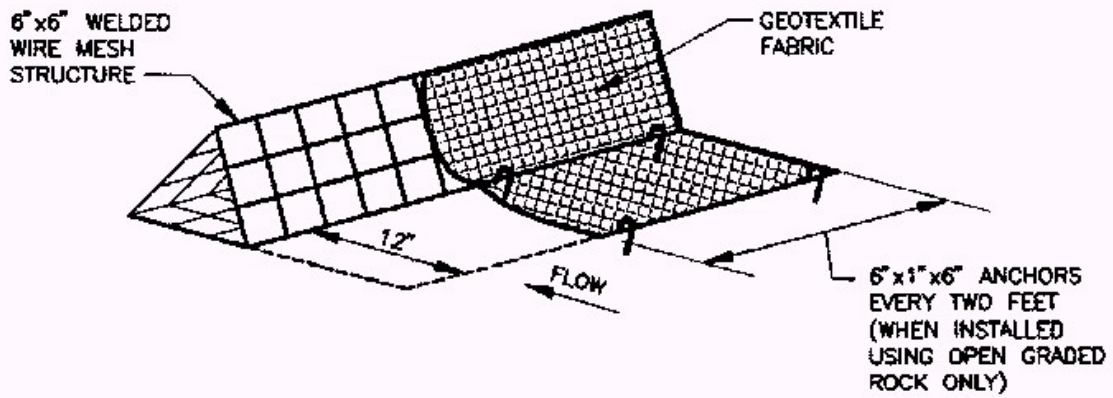
- C. Triangular Sediment Filter Dikes.
1. The purpose of a triangular sediment filter dike is to intercept and detain water-borne sediment from unprotected areas of limited extent. The triangular sediment filter dike is used where there is no concentration of water in a channel or other drainage way above the barrier and the contributing drainage area is less than one acre. If the uphill slope above the dike exceeds 10%, the length of the slope above the dike should be less than 50 feet. If concentrated flow occurs after installation, corrective action should be taken such as placing rock berm in the areas of concentrated flow. This measure is effective on paved areas where installation of silt fence is not possible or where vehicle access must be maintained. The advantage of these controls is the ease with which they can be moved to allow vehicle traffic, then reinstalled to maintain sediment control.
 2. Materials:
 - a. Silt fence material should be polypropylene, polyethylene or polyamide woven or non-woven fabric. The fabric width should be 36 inches, with a minimum unit weight of 4.5 oz./yd., mullen burst strength exceeding 190 lb/in², ultraviolet stability exceeding 70%, and minimum apparent opening size of U.S. Sieve No. 30.
 - b. The dike structure should be 6-gauge 6" x 6" wire mesh folded into triangular form being eighteen (18) inches on each side.
 3. Installation:
 - a. As shown in the schematic below, the frame should be constructed of 6" x 6", 6 gauge welded wire mesh, 18 inches per side, and wrapped with geotextile fabric the same composition as that used for silt fences.
 - b. Filter material should lap over ends six (6) inches to cover dike to dike junction; each junction should be secured by shoat rings.
 - c. Position dike parallel to the contours, with the end of each section closely abutting the adjacent sections.
 - d. There are several options for fastening the filter dike to the ground as shown in schematic below. The fabric skirt may be toed-in with 6 inches of compacted material, or 12 inches of the fabric skirt should extend uphill and be secured with a minimum of 3 inches of open graded rock, or with staples or nails. If these two options are not feasible the dike structure may be trenched in 4 inches.
 - e. Triangular sediment filter dikes should be installed across exposed slopes during construction with ends of the dike tied into existing grades to prevent failure and should intercept no more than one acre of runoff.
 - f. When moved to allow vehicular access, the dikes should be reinstalled as soon as possible, but always at the end of the workday.
 4. Schematic Diagram of a Triangular Sediment Filter Dike:



CROSS SECTION OF INSTALLATION OPTIONS

N.T.S.

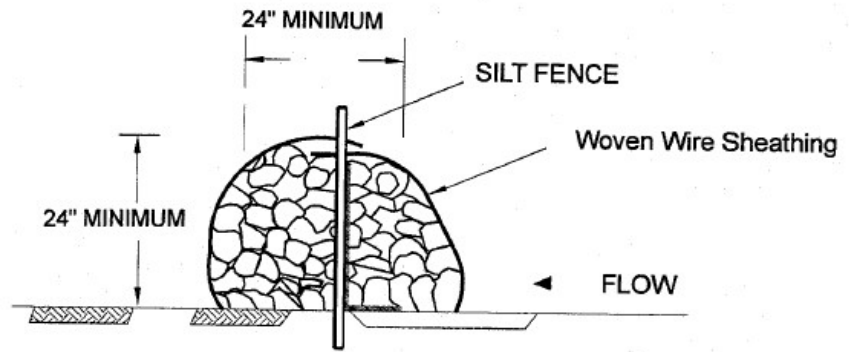
1. TOE-IN 6" MIN
2. WEIGHTED W/ 3" - 5" OPEN GRADED ROCK
3. TRENCHED IN 4"



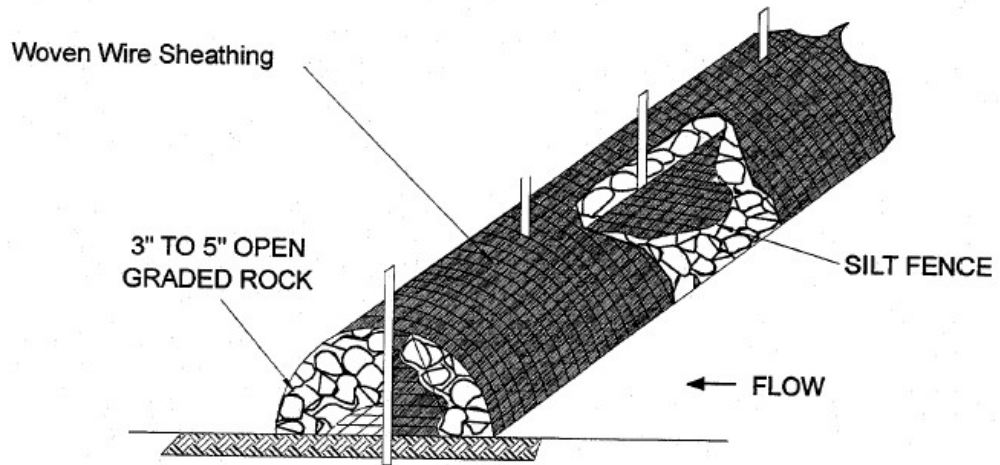
ISOMETRIC PLAN VIEW

N.T.S.

- D. High Service Berm.
1. Materials:
 - a. Silt fence material should be polypropylene, polyethylene or polyamide woven or nonwoven fabric. The fabric width should be 36 inches, with a minimum unit weight of 4.5 oz./yd., mullen burst strength exceeding 190 lb/in², ultraviolet stability exceeding 70%, and minimum apparent opening size of U.S. Sieve No. 30.
 - b. Fence posts should be made of hot rolled steel, at least 4 feet long with Tee or Y-bar cross section, surface painted or galvanized, minimum nominal weight 1.25 lb/ft², and Brindell hardness exceeding 140. Rebar (either #5 or #6) may also be used to anchor the berm.
 - c. Woven wire backing to support the fabric should be galvanized 2" x 4" welded wire, 12 gauge minimum.
 - d. The berm structure should be secured with a woven wire sheathing having maximum opening of 1 inch and a minimum wire diameter of 20 gauge galvanized and should be secured with shoit rings.
 - e. Clean, open graded 3-to 5-inch diameter rock should be used, except in areas where high velocities or large volumes of flow are expected, where 5-to 8-inch diameter rocks may be used.
 2. Installation:
 - a. Lay out the woven wire sheathing perpendicular to the flow line. The sheathing should be 20 gauge woven wire mesh with 1-inch openings.
 - b. Install the silt fence along the center of the proposed berm placement, as with a normal silt fence described in Section 3.2 B.
 - c. Place the rock along the sheathing on both sides of the silt fence as shown in the diagram below, to a height not less than 24 inches. Clean, open graded 3-5" diameter rock should be used, except in areas where high velocities or large volumes of flow are expected, where 5-to 8-inch diameter rock may be used.
 - d. Wrap the wire sheathing around the rock and secure the tie wire so that the ends of the sheathing overlap at least 2 inches, and the berm retains its shape when walked upon.
 - e. The high service rock berm should be removed when the site is revegetated or otherwise stabilized or it may remain in place as a permanent BMP if drainage is adequate.
 3. Common Trouble Points:
 - a. Insufficient berm height or length (runoff quickly escapes over top or around sides of berm).
 - b. Berm not installed perpendicular to flow line (runoff escaping around one side).
 - c. Internal silt fence not anchored securely to ground (high flows displacing berm).
 - d. When installed in streambeds, they often result in diversion scour, so their use in this setting is not recommended.
 4. Inspection and Maintenance Guidelines:
 - a. Inspection should be made weekly and after each rainfall by the responsible party. For installations in streambeds, additional daily inspections should be made on rock berm.
 - b. Remove sediment and other debris when buildup reaches 6 inches and dispose of the accumulated silt of in an approved manner.
 - c. Repair any loose wire sheathing.
 - d. The berm should be reshaped as needed during inspection.
 - e. The berm should be replaced when the structure ceases to function as intended due to silt accumulation among the rocks, washout, construction traffic damage, etc.
 - f. The rock berm should be left in place until all upstream areas are stabilized and accumulated silt removed.
 5. Schematic Diagram of a High Service Rock Berm (LCRS, 1998):



Cross - Section



END OF SECTION

DIVISION 02

Existing Conditions

95% Construction Documents

SECTION 024113 - SELECTIVE SITE DEMOLITION AND REMOVALS

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. Provide all equipment and do all work necessary to demolish and/or remove the structures, including walls, fences, curbs and pavements indicated, and prepare the site as indicated on the Drawings.
- B. Related Sections:
1. Section 015639 "Temporary Tree and Plant Protection"
 2. Section 024116 "Structural Demolition".
 3. Section 024296 "Historic Removal and Dismantling."

1.3 SUBMITTALS

- A. The following shall be submitted:
1. Permit for transport and legal disposal off-site of demolition material and debris as required.
 2. Demolition procedures and operational sequence for review and acceptance by Landscape Architect.
 3. Location plan of staging areas and schedule for moving staging equipment into those areas shall be submitted for Landscape Architect's approval prior to mobilization and related site preparation operations.
 4. A list of all site operations and programs to be accommodated during construction period.
 5. Submit procedures for means and methods for salvaged and stockpiled materials. Include an itemized photographic inventory with description of the items. The description shall include the location of the item on site, an evaluation of the condition and recommendations in a catalog format.
- B. Predemolition Photographs: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Submit before the Work begins.

1.4 QUALITY ASSURANCE

- A. Predemolition Conference: Conduct conference at Project site prior to the start of work with the Owner, Owner's representative, Project Architects, Structural Engineer and Landscape Architect.

1.5 PROTECTION

- A. Do not interfere with use of adjacent buildings. Maintain free and safe passage to and from.
- B. Prevent movement or settlement of adjacent structures. Provide and place bracing or shoring and be responsible for safety and support of structures. Assume liability for such movement, settlement, damage, or injury.

1.6 MAINTAINING TRAFFIC

- A. Do not close or obstruct roadways without permits and or written permission.
- B. Conduct operations with minimum interference to offsite public or private roadways.

1.7 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition shall remain the property of Owner.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

PART 2 PRODUCTS

2.1 STOCKPILING

- A. Materials indicated on plans for stockpiling shall be restored to "like-new" condition utilizing state of the art means and methods to be submitted and approved by Owner. Keep records of where material was salvaged from and segregate materials by area and submit to owner.

2.2 SALVAGING

- A. Materials indicated on the Drawings or designated in the field by the Owner to be salvaged shall be carefully removed and delivered to a location on site to be determined by the Owner.
- B. Mechanical and electrical items to be salvaged shall be protected from the weather.
- C. Miscellaneous Salvage: Due to the Historic significance of this site special consideration shall be given to stone and other items that may be discovered during excavation and grading work. It is desired that any stone cobble rubble blocks or otherwise is salvaged and stockpiled for reuse.
- D. Storage requirements during construction. Storage site/location to be determined and reviewed by Landscape Architect and Owner.

PART 3 EXECUTION

3.1 DEMOLITION

- A. The intent of the drawings indicate all of the items to be removed but may not include all structures, trees shrubs, rootballs or other hidden conditions that require removal or remediation. Report any items to the Owner or Landscape Architect that require removal that are not shown on the drawings in writing.
- B. Structures, including trees and rootballs indicated to be removed shall be completely removed including foundations, except when approved by the Landscape Architect, to a minimum of 4 ft. below finished grade for graded areas.
- C. Remove from site and disposed of by safe means so as not endanger health of workers and public.
- D. Backfill areas excavated as a result of demolition.
- E. Rough grade areas affected by demolition and leave areas level, maintaining grades and contours of site.
- F. Site Access and Temporary Controls: Conduct demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

3.2 REMOVALS

- A. Materials indicated on the Drawings or designated by the Landscape Architect in the field to be removed shall be dismantled, removed, and legally disposed of off-site or stockpiled as indicated on the Drawings.
- B. Areas formerly occupied by structures shall be regraded to conform with surrounding topography following demolition.
- C. Remove all existing play structures, footings and other associated play structures from the site

3.3 STOCKPILED MATERIALS

- A. Materials indicated on the Drawings or designated by the Landscape Architect in the field to be salvaged shall be carefully removed, protected from damage, and put in temporary storage. Keep records of where material was salvaged from and segregate materials by area.

3.4 SALVAGEABLE MATERIALS

- A. Materials indicated on the Drawings or designated by the Landscape Architect in the field to be salvaged shall be carefully removed, protected from damage, and put in temporary storage.
- B. Clean salvaged items of all deleterious material without altering the condition or integrity of the object.

3.5 PROTECTION OF EXISTING STRUCTURES AND UTILITIES

- A. Existing memorials, fences, stone walls, catch basins, structures and utilities shall be suitably protected from damage.

3.6 PAVEMENT AND CURB REMOVAL

- A. Where pavement and/or curb to be removed abuts pavement and curb to remain, a neat, straight saw cut shall be made with a concrete power saw.
 - 1. Pavement and/or curb removal shall include removal of subbase as required to accommodate proposed construction materials.

3.7 DISPOSAL OF MATERIALS

- A. Material resulting from demolition and not scheduled for salvaging shall become the property of the Contractor and shall be suitably disposed of off-site. Disposal shall be performed as promptly as possible and not left until the final clean up.
- B. Debris, rubbish, and other material shall be disposed of promptly and shall not be left until final cleanup of site.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Selective demolition of building elements for alteration purposes.

1.2 RELATED REQUIREMENTS

- A. Section 003100 - Available Project Information: Existing building survey conducted by Owner; information about known hazardous materials.
- B. Section 011000 - Summary: Limitations on Contractor's use of site and premises.
- C. Section 011000 - Summary: Description of items to be salvaged or removed for re-use by Contractor.
- D. Section 015000 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.
- E. Section 015713 - Temporary Erosion and Sediment Control.
- F. Section 016000 - Product Requirements: Handling and storage of items removed for salvage and relocation.
- G. Section 017000 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring.
- H. Section 017419 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.

1.3 REFERENCE STANDARDS

- A. 29 CFR 1926 - U.S. Occupational Safety and Health Standards; current edition.
- B. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2019.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Site Plan: Showing:
 - 1. Areas for temporary construction and field offices.
 - 2. Areas for temporary and permanent placement of removed materials.
- C. Demolition Plan: Submit demolition plan as specified by OSHA and local authorities.
 - 1. Indicate extent of demolition, removal sequence, bracing and shoring, and location and construction of barricades and fences.
 - a. Shoring plan shall be prepared under the direct supervision of a professional engineer. Shop drawings shall be signed and sealed by Registered Professional Engineer.
 - 2. Identify demolition firm and submit qualifications.
- D. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

1.5 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: Company specializing in the type of work required.
 - 1. Minimum of 5 years of documented experience.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Fill Material: As specified in Section 312323 - Fill.

PART 3 EXECUTION

3.1 SCOPE

- A. Selective demolition of building elements for alteration purposes.

-
- B. Within area of new construction, remove foundation walls and footings to a minimum of 2 feet below finished grade.
 - C. Outside area of new construction, remove foundation walls and footings to a minimum of 2 feet below finished grade.
 - D. Remove concrete slabs on grade within site boundaries.
 - E. Remove other items indicated, for salvage, relocation, and recycling.
 - F. Fill excavations, open pits, and holes in ground areas generated as result of removals, using specified fill; compact fill _____.
- 3.2 GENERAL PROCEDURES AND PROJECT CONDITIONS
- A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain required permits.
 - 2. Comply with applicable requirements of NFPA 241.
 - 3. Use of explosives is not permitted.
 - 4. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 - 5. Provide, erect, and maintain temporary barriers and security devices.
 - 6. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
 - 7. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
 - 8. Do not close or obstruct roadways or sidewalks without permit.
 - 9. Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.
 - 10. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon or limit access to their property.
 - B. Do not begin removal until receipt of notification to proceed from Owner.
 - C. Protect existing structures and other elements that are not to be removed.
 - 1. Provide bracing and shoring.
 - 2. Prevent movement or settlement of adjacent structures.
 - 3. Stop work immediately if adjacent structures appear to be in danger.
 - D. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.
 - E. If hazardous materials are discovered during removal operations, stop work and notify Architect/Structural Engineer of Record and Owner; hazardous materials include regulated asbestos containing materials, lead, PCB's, and mercury.
- 3.3 EXISTING UTILITIES
- A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
 - B. Protect existing utilities to remain from damage.
 - C. Do not disrupt public utilities without permit from authority having jurisdiction.
 - D. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Owner.
 - E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to Owner.
 - F. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.
 - G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.
 - H. Prepare building demolition areas by disconnecting and capping utilities outside the demolition zone; identify and mark utilities to be subsequently reconnected, in same manner as other utilities to remain.

3.4 SELECTIVE DEMOLITION FOR ALTERATIONS

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - 1. Verify that construction and utility arrangements are as indicated.
 - 2. Report discrepancies to Architect/Structural Engineer of Record before disturbing existing installation.
 - 3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
- B. Remove existing work as indicated and as required to accomplish new work.
 - 1. Remove items indicated on drawings.
- C. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove existing systems and equipment as indicated.
 - 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
 - 2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - 3. Verify that abandoned services serve only abandoned facilities before removal.
 - 4. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification.
- D. Protect existing work to remain.
 - 1. Prevent movement of structure; provide shoring and bracing if necessary.
 - 2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
 - 3. Repair adjacent construction and finishes damaged during removal work.
 - 4. Patch as specified for patching new work.

3.5 DEBRIS AND WASTE REMOVAL

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

END OF SECTION

SECTION 02 29 96 – HISTORIC REMOVAL AND DISMANTLING

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 historic treatment procedures in the form of special types of selective demolition work for designated historic spaces, areas, rooms, clay tile roof material and surfaces and the following specific work:
 - 1. Removal and dismantling of indicated portions of building or structure and debris hauling.
 - 2. Removal and dismantling of indicated site elements and debris hauling.
 - 3. Salvage of existing items to be reused or recycled.
- B. Related Requirements:
 - 1. Section 01 35 91 – Historic Treatment Procedures: General historic treatment requirements.
 - 2. Section 02 41 16 – Structure Demolition: Demolition of buildings and site improvements.
 - 3. Section 07 32 13 – Clay Tile Roofing.

1.3 DEFINITIONS

- A. Dismantle: To disassemble or detach a historic item from a surface, or a non-historic item from a historic surface, using gentle methods and equipment to prevent damage to historic items and surfaces; disposing of items unless indicated to be salvaged or reinstalled.
- B. Existing to Remain: Existing items that are not to be removed or dismantled, except to the degree indicated for performing required Work.
- C. Remove: To take down or detach a non-historic item located within a historic space, area, or room, using methods and equipment to prevent damage to historic items and surfaces; disposing of items unless indicated to be salvaged or reinstalled.
- D. Retain: To keep existing items that are not to be removed or dismantled.
- E. Salvage: To protect removed or dismantled items and deliver them to Owner or reinstall.

1.4 PRECONSTRUCTION MEETINGS

- A. Preconstruction Conference(s): Conduct conference(s) at General Contractor's field office adjacent to Project site.
 - 1. Review minutes of Preliminary Historic Treatment Conference that pertain to removal and dismantling procedures and protection of historic areas and surfaces.
 - 2. Review list of items indicated to be salvaged.
 - 3. Verify qualifications of personnel assigned to perform removal and dismantling.
 - 4. Inspect and discuss condition of each construction type to be removed or dismantled.
 - 5. Review requirements of other work that depends on condition of substrates exposed by removal and dismantling work.
 - 6. Review methods and procedures related to removal and dismantling work, including, but not limited to, the following:
 - a. Historic removal and dismantling specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, material application, sequencing, tolerances, and required clearances.
 - c. Fire prevention.
 - d. Coordination with building occupants.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For historic removal and dismantling specialist and historic removal and dismantling specialist's field supervisors.
- B. Preconstruction Documentation: Show preexisting conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by Contractor's removal and dismantling operations.
- C. Removal and Dismantling Historic Treatment Program: Submit 30 days before work begins.
- D. List of Items Indicated to Be Salvaged: Prepare a list of items indicated on Drawings to be salvaged for Owner's use or for reinstallation. Submit 15 days before preconstruction conference.
- E. Inventory of Salvaged Items: After removal or dismantling work is complete, submit a list of items that have been salvaged.
 - 1. Include item description, item condition, number of items if more than one of a type, and tag number.
 - 2. As work proceeds, include on the inventory items that were indicated to be salvaged and items of historic importance discovered during the work. Document reasons, if any, why an item indicated to be salvaged was not salvaged.

1.6 QUALITY ASSURANCE

- A. Historic Removal and Dismantling Specialist Qualifications: A qualified historic treatment specialist. General selective demolition experience is insufficient experience for historic removal and dismantling work.
- B. Removal and Dismantling Historic Treatment Program: Prepare a written, detailed description of materials, methods, equipment, and sequence of operations to be used for each phase of removal and dismantling work, including protection of surrounding and substrate materials and Project site.
 - 1. Dust and Noise Control: Include locations of proposed temporary dust- and noise-control partitions and means of egress from occupied areas coordinated with continuing on-site operations and other known work in progress.
 - 2. Debris Hauling: Include plans clearly marked to show debris hauling routes, turning radii, and locations and details of temporary protective barriers.
- C. Regulatory Requirements: Comply with notification regulations of authorities having jurisdiction before beginning removal and dismantling work. Comply with hauling and disposal regulations of authorities having jurisdiction.

1.7 FIELD CONDITIONS

- A. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- B. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with removal and dismantling work.
- C. Hazardous Materials: Hazardous materials are present in construction affected by removal and dismantling work. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
 - 1. Hazardous material remediation is specified elsewhere in the Contract Documents.
 - 2. Do not disturb hazardous materials or items suspected of containing hazardous materials, except under procedures specified elsewhere in the Contract Documents.
 - 3. If unanticipated asbestos is suspected, stop work in the area of potential hazard, shut off fans and other air handlers ventilating the area, and rope off area until the questionable material is identified. Reassign workers to continue work in unaffected areas. Resume work in the area of concern after safe working conditions are verified.
- D. Storage or sale of removed or dismantled items on-site is not permitted unless otherwise indicated.
- E. Do not remove materials when rain is forecasted or in progress.

PART 2 - PRODUCTS - (Not Used)

PART 3 - EXECUTION

3.1 HISTORIC REMOVAL AND DISMANTLING EQUIPMENT

- A. Removal Equipment: Use only hand-held tools, except as follows or unless otherwise approved by Architect on a case-by-case basis:
 - 1. Light jackhammers are allowed subject to Architect's approval.
 - 2. Large air hammers are not permitted.
- B. Dismantling Equipment: Use manual, hand-held tools, except as follows or otherwise approved by Architect on a case-by-case basis:
 - 1. Hand-held power tools and cutting torches are permitted only as submitted in the historic treatment program. They must be adjustable so as to penetrate or cut only the thickness of material being removed.
 - 2. Pry bars more than 18 inches (450 mm) long and hammers weighing more than 2 lb (0.9 kg) are not permitted for dismantling work.

3.2 EXAMINATION

- A. Preparation for Removal and Dismantling: Examine construction to be removed or dismantled to determine best methods to safely and effectively perform removal and dismantling work. Examine adjacent work to determine what protective measures are necessary. Make explorations, probes, and inquiries as necessary to determine condition of construction to be removed or dismantled and location of utilities and services to remain that may be hidden by construction that is to be removed or dismantled.
 - 1. Verify that affected utilities are disconnected and capped.
 - 2. Inventory and record the condition of items to be removed and dismantled for reinstallation or salvage. Enter this information on the submittal of inventory of salvaged items.
 - 3. Before removal or dismantling of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.
 - 4. Engineering Survey: Review Project professional engineer's survey condition of historic building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure as a result of removal and dismantling work.
- B. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs.
 - 1. Comply with requirements specified in Section 013233 "Photographic Documentation."
- C. Perform surveys as the Work progresses to detect hazards resulting from historic removal and dismantling procedures.

3.3 HISTORIC REMOVAL AND DISMANTLING

- A. General: Have removal and dismantling work performed by a qualified historic removal and dismantling specialist. Ensure that historic removal and dismantling specialist's field supervisors are present when removal and dismantling work begins and during its progress. Salvage representative materials such as masonry, wood, hardware and architectural metals in good condition for potential reuse.
- B. Perform work according to the historic treatment program.
 - 1. Perform removal and dismantling to the limits indicated.
 - 2. Provide supports or reinforcement for existing construction that becomes temporarily weakened by removal and dismantling work, until the Project Work is completed unless otherwise indicated.
 - 3. Perform cutting by hand or with small power tools wherever possible. Cut holes and slots neatly to size required, with minimum disturbance of adjacent work.
 - 4. Do not operate air compressors inside building unless approved by Architect in each case.

5. Do not drill or cut columns, beams, joints, girders, structural slabs, or other structural supporting elements, without having Contractor's professional engineer's written approval for each location before such work is begun.
6. Dispose of removed and dismantled items off-site unless indicated to be salvaged or reinstalled.
- C. Water-Mist Sprinkling: Use water-mist sprinkling and other wet methods to control dust only with adequate, approved procedures and equipment according to the historic treatment program to ensure that such water does not create a hazard or adversely affect other building areas or materials.
- D. Unacceptable Equipment: Keep equipment that is not permitted for historic removal or dismantling work away from the vicinity where such work is being performed.
- E. Removing and Dismantling Items on or Near Historic Surfaces:
 1. Use only dismantling equipment and procedures within 12 inches (300 mm) of historic surface. Do not use pry bars. Protect historic surface from contact with or damage by tools.
 2. Unfasten items in the opposite order from which they were installed.
 3. Support each item as it becomes loosened to prevent stress and damage to the historic surface.
 4. Dismantle anchorages.
- F. Masonry Walls:
 1. Remove masonry carefully, and erect temporary bracing and supports as needed to prevent collapse of materials being removed.
 2. Dismantle top edge and sides before removing wall. Stop removal work and immediately inform Architect if any structural elements above or adjacent to the work show signs of distress or dislocation during any phase of removal work.
 3. Remove wall in easily managed pieces.
 4. During removal, maintain the stability of the partially remaining wall. Notify Architect of the condition of temporary bracing for wall if work is temporarily stopped during the wall's removal.
- G. Steelwork:
 1. Expose structural steel for examination by Architect and Contractor's professional engineer before proceeding with removal or dismantling.
 2. If distress in structure is apparent during performance of the work, stop removal or dismantling and take immediate precautionary measures to ensure safety of the structure. Inform Architect of the problem, steps taken, and proposed corrective actions.
 3. Brace and support structural steel being removed and remaining during removal and dismantling.
 4. Concrete-Encased Steel: Where steel is known to be encased by concrete that is being removed, saw cut with blades that can cut no deeper than the thickness of the concrete cover, with an adequate margin for error in the location of the steel. Isolate sections of concrete by saw cutting before beginning removal.
- H. Anchorages:
 1. Remove anchorages associated with removed items.
 2. Dismantle anchorages associated with dismantled items.
 3. In non-historic surfaces, patch holes created by anchorage removal or dismantling according to the requirements for new work.
 4. In historic surfaces, patch or repair holes created by anchorage removal or dismantling according to Section that is specific to the historic surface being patched.
- I. Clay Tile Roofing:
 1. Carefully examine, measure and record existing tile patterns at edges, hips, ridges, texture, finish, color blend, blend percentages, exposure, fittings, covers, trim, physical characteristics, and other special conditions for reference in reinstallation. Measure the exposed dimensions and amount of lap of each type piece prior to removal as well as length, width and thickness after removal.
 2. Remove clay tiles at Restroom Pavilion A and Electric Pump House #3 parapet carefully.
 3. Inspect each tile for damage and retain only sound tiles.

4. The Contractor shall take all precautions necessary to salvage existing tile intact as the tiles are removed from Electric Pump House #3 and Restroom Pavilion A.
5. Chipped, cracked and broken tiles shall be discarded. The Architect will inspect chipped tile and may accept tile with minor chips.
6. Contaminants such as mortar, sealant, and/or roofing cement shall be removed from salvaged tile to the greatest extent possible. The Architect shall determine what contaminants are acceptable and may remain. Tiles broken in the cleaning process shall be discarded.
7. Sort by building and store tile roofing materials in a dry location. Place on platforms off the ground covered with waterproof coverings which will not produce any condensation, if stored outside. The Contractor shall stock the salvaged tile in a location coordinated with the Owner.
8. Stack tiles so that the loads are properly placed as not to damage the tiles and the tiles are located for minimum handling. Do not stack or store the roofing materials on the roof structure. Improper loads may cause the structure to fail. Tiles shall be stacked no higher than recommended by Ludowici or other qualified replicator. Block tiles to avoid slippage and/or toppling.
9. Remove no more than can be replaced or where roof removal zone can be protected or repaired in one day.
10. Protect from mechanical damage incurred by walking on tiles or by tools. Utilize heavy pads and ridge ladders to equalize a person's weight whenever any work is done on the roof.
11. Every precaution shall be taken to ensure rake and special shape tiles remain unbroken during tile removal, repairs and re-installation. In the event any that these tile are broken the Contractor shall replace with an in-kind match or order special replacement pieces from Basis-of-Design Ludowici. For replication purposes, send removed physical samples to Ludowici Technical Department for analyzing and identifying the tile for fabrication. Access the Ludowici form using the following link: <https://ludowici.my.site.com/IncomingSamples/s/>.

The submittal process is below:

1. Click Create a New Incoming Sample button.
2. Name the project Brackenridge Park Restroom Pavilions
3. Complete the Project Address section.
4. Enter your Company information
5. Name Cindy Walker as the Sales Representative. Cindy.Walker@ludowici.com
6. Make sure to use your email to confirm.
7. Pick Number of Samples Shipped and
8. Pick what you want to have happen. Confirm with Architect.
9. Click NEXT.
10. Upload any picture.
11. Then Upload and Submit.
12. You should get a message, and then an email will be sent to you as the customer and the sales representative.
13. Within a few minutes, you will receive an email, with an attached PDF that WOULD BE INCLUDED IN THE BOX you are using to ship the samples.
14. Please pack samples carefully and securely to avoid breakage in shipment – it is best to use bubble wrap in addition to other packing materials.

END OF SECTION 02 42 96

DIVISION 03

Concrete

95% Construction Documents

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Repair of exposed structural, shrinkage, and settlement cracks.
- B. Resurfacing of concrete surfaces having spalled areas and other damage.
- C. Repair of deteriorated concrete.
- D. Repair of internal concrete reinforcement.

1.2 RELATED REQUIREMENTS

- A. Section 013591 - Historic Preservation Treatment Procedures
- B. Section 033000 - Cast-in-Place Concrete: Finishing of concrete surface to tolerance; floating, troweling, and similar operations; curing.

1.3 DEFINITIONS

- A. Carbon Fiber Reinforced Polymer (CFRP): Composite material comprising a polymer matrix reinforced with carbon fiber cloth, mat, or strands.

1.4 REFERENCE STANDARDS

- A. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.
- B. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2022.
- C. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2018.
- D. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2023.
- E. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 50 mm [2 in.] Cube Specimens); 2023.
- F. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.
- G. ASTM C404 - Standard Specification for Aggregates for Masonry Grout; 2018.
- H. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 2020a.
- I. ASTM C928/C928M - Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs; 2020a.
- J. ASTM C1059/C1059M - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete; 2021.
- K. ASTM D3039/D3039M - Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials; 2017.
- L. AWS D1.4/D1.4M - Structural Welding Code - Steel Reinforcing Bars; 2018, with Amendment (2020).
- M. ICC-ES AC178 - Acceptance Criteria for Inspection and Verification of Concrete and Reinforced and Unreinforced Masonry Strengthening Using Fiber-Reinforced Polymer (FRP) or Steel-Reinforced Polymer (SRP) Composite Systems; 2017, with Editorial Revision (2020).
- N. ICRI 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair; 2013.
- O. Additional Reference Guides:
 - 1. Paul Gaudette and Deborah Slaton. Preservation Briefs 15: Preservation of Historic CONCRETE. WASHINGTON, D.C.: NATIONAL PARK SERVICE, 2007.
 - 2. American Concrete Institute. ACI PRC-515.3-20, Guide for Assessment and Surface Preparation for Application of Protection Systems for Concrete.
 - 3. American Concrete Institute. ACI PRC-546-14, Guide to Concrete Repair.
 - 4. Ann Harrer, Paul Gaudette, and Deborah Slaton. "Approach to Preservation of Historic Concrete." Concrete Repair Bulletin, March/April 2020, 12-17.

1.5 SUBMITTALS

- A. See Section 013000 - Submittal Procedures.

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- B. Product Data: Indicate product standards, physical and chemical characteristics, technical specifications, limitations, maintenance instructions, and general recommendations regarding each material.
 - C. Shop Drawings for Applied Composite Repairs: Provide shop drawings signed and sealed by Professional Engineer indicating:
 - 1. Repair location.
 - 2. Repair details.
 - 3. Fiber type, dimensions, number, thickness, and direction of layers.
 - 4. Installation sequence.
 - 5. Splice details.
 - 6. Joint and end details.
 - 7. Anchorage.
 - 8. Connections.
 - D. Manufacturer's instructions.
 - E. Field quality control submittals.
 - F. Field quality control submittals for CFRP.
- 1.6 QUALITY ASSURANCE
- A. The contractor shall have experience on similar projects and historic preservation. High levels of craftsmanship on these types of projects are required for successful repairs that match the existing shaft.
 - B. Designer Qualifications: Perform design under direct supervision of Professional Engineer experienced in historic concrete repairs of this type of work and licensed in Texas.
 - C. Manufacturer Qualifications: Company specializing in manufacturing products associated with repairing historic concrete, with not less than three years of documented experience.
 - D. Cleaner Qualifications: Company specializing in, and with minimum of 3 years of experience in, the type of cleaning specified.
 - E. Installer Qualifications: Company specializing in performing historic concrete repair work of the type specified and with minimum of 3 years of documented experience.
 - F. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.4/D1.4M and dated no more than 12 months before start of scheduled welding work.
- 1.7 MOCK-UPS
- A. Refer to architectural drawings sheet A1.2 Items #1 and # 2 for required mock-ups.
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. Comply with manufacturers' instructions for storage, shelf life limitations, and handling of products.
 - B. Deliver polymer resin materials in original factory-sealed containers with manufacturer's labels intact and legible. Verify product nomenclature, manufacturer's name, product identification, batch number, date of manufacture, and shelf life or expiration date. Do not use polymer resin materials that have exceeded shelf life.
 - C. Store materials in covered, well-ventilated area and according to manufacturer's written storage instructions. Store polymer resins and hardeners separate from construction materials that can absorb odors.

PART 2 PRODUCTS

2.1 CLEANING OF CONCRETE

- A. Clean entirety of concrete shaft per Specification Section 030301 prior to patching work. All color matching patches shall match the cleaned concrete surface.

2.2 REBAR AND STEEL CLEANING/COATING

- A. Cleaning of Rebar

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1. Rust, scale, mortar, concrete, dust and other loose and deleterious material which reduces bond or contributes to corrosion shall be removed by blast cleaning or other means of mechanical abrasion and reinforcement.
 - B. Coat all existing reinforcing
 1. Products
 - a. Armatec-10 Primer
 - b. Armatec-108 Reinforcement Corrosion Protection
 - c. Armatec-110 EpoCem Reinforcement Corrosion Protection
 - d. Substitutions: See Section 016000 - Product Requirements.
- 2.3 HISTORIC CONCRETE SPALL REPAIR MATERIALS
- A. Manufacturers:
 1. TintCrete Concrete by JE Tomes: www.jetomes.com
 2. Substitutions: See Section 016000 - Product Requirements.
 - B. Spall Repair Materials
 1. Pour and Pump 1 component color tinted polymer modified high flow concrete mix with corrosion inhibitor
 2. Provide custom color match product
 - a. The repair material is to match the color, texture, and finish of the existing concrete shaft. There is variation in the color, texture, and finish that the repair material shall match.
 3. Minimum thickness of $\frac{3}{4}$ "
 4. Maximum thickness of 24"
 5. Ensure proper water ratio and mixing procedure:
 - a. Force mixing is required with a slow speed drill with a paddle mixer or appropriately sized mortar mixer. Barrel mixers are not recommended. Approximately 3.5 qt of water is required to mix 65 lb of product. Inconsistent water/cement ratio will affect color. When using a hand drill, add dry product slowly while mixing or introduce product in increments and mix in between to reduce lumping and ensure consistency. Mix for 1 minute varying depth of paddle in mixing container. Do not exceed 3.5 qt of water. Allow to sit 30 seconds, thus allowing additives to take effect then continue mixing for an additional 1 minute. Recommended slump is 4" to 8.
 - C. Ensure reinforcing is compatible with repair mix
- 2.4 HISTORIC CONCRETE CRACK PATCHING REPAIR MATERIALS
- A. Manufacturers:
 1. "TintCrete Patch" by JE Tomes: www.jetomes.com
 2. Substitutions: See Section 016000 - Product Requirements.
 - B. Crack Repair Materials
 1. Troweled 1 component color tinted polymer, modified high performance concrete repair and resurfacing mortar
 2. Provide custom color match product
 - a. The repair material is to match the color, texture, and finish of the existing concrete shaft. There is variation in the color, texture, and finish that the repair material shall match
 3. Minimum thickness of feathered edge
 4. Maximum thickness of 1 $\frac{1}{2}$ "
 5. Ensure proper water ratio and mixing procedure:
 6. Ensure reinforcing is compatible with repair mortar
- 2.5 ACCESSORIES
- A. Anchoring Adhesive: Self-leveling or non-sag as applicable.
 1. Self-Leveling Polyester-Based Products:
 - a. W. R. Meadows, Inc; Poly-Grip: www.wrmeadows.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
 - B. Portland Cement: ASTM C150/C150M, Type I, grey.
 - C. Sand: ASTM C33/C33M or ASTM C404; uniformly graded, clean.

- D. Water: Clean and potable.
- E. Reinforcing Steel: ASTM A615/A615M Grade 60 (60,000 psi) billet-steel deformed bars, unfinished.
- F. Stirrup Steel: ASTM A1064/A1064M.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Beginning of installation means acceptance of substrate.

3.2 HISTORIC CONCRETE SPALL REPAIR

- A. Clean entirety of the shaft per spec section 030301
- B. Remove all loose concrete & remove minimum 2" beyond unsound or deteriorated area. Removal geometry to be regular & without reentrant corners take care to prevent sawcutting of existing reinforcement bars is limited is to be taken.
- C. Remove concrete to a depth of a minimum of 3/4" behind existing. Reinforcement bars. Depth of removal to be consistent throughout each repair area. Use of 15lb (maximum) chipping hammers only.
- D. If exposed rebar is present, clean exposed rebar with abrasive blast cleaning, to best extent possible. Coat exposed and cleaned rebar with sika armatec 10 zr primer, sika armatec 110 epocem, or equivalent prior to concrete patching.
- E. Verify extents of spalling and initiate a 3/4" deep saw cut at a minimum of 2" beyond furthestmost point of each spall on each side. Take care to not cut existing rebar during saw cutting. Ref details in structural drawings based on approximate spall sizes.
- F. Prep and coat newly exposed rebar (if any from saw cutting) per note B
- G. Clean & prepare exposed concrete surface for repair with abrasive blast cleaning & dry.
- H. Batch mixing. Force mixing is recommended with a slow speed drill with a paddle mixer or appropriately sized mortar mixer. Barrel mixers are not recommended. Approximately 3.5 qt of water is required to mix 65 lb of product. Inconsistent water/cement ratio will affect color. When using a hand drill, add dry product slowly while mixing or introduce product in increments and mix in between to reduce lumping and ensure consistency. Mix for 1 minute varying depth of paddle in mixing container. Do not exceed 3.5 qt of water. Allow to sit 30 seconds, thus allowing additives to take effect then continue mixing for an additional 1 minute. Recommended slump is 4" to 8". Ensure color of mix is consistent with approved color samples.
- I. Pour into a form the Tintcrete Concrete by je tomes, inc. or equivalent to the fully exposed spalled and saw cut concrete surface per manufacturer's instructions. Apply to a clean, dry, sound substrate, with ambient temperature above 40° F. Substrate is to be saturated surface dry (SSD), if applicable, but otherwise hold no standing water prior to application. Check moisture content (mat test) prior to applying any waterproof topping. Do not retemper already mixed material. Do not expose to rain or flowing water during application. The concrete repair material shall be color and texture matched per architectural requirements within Mock-up notes on sheet a1.2.
- J. Curing. Rapid drying of cement-based products may cause cracking or de-bonding. Avoid applications in high winds, excessive heat or blowing air directly on freshly placed product. Curing compounds, wet burlap or polyethylene will reduce rapid drying but may cause color change or mar product surface. Allow material to cure in form for 2 or more days before change or mar product surface. Allow material to cure in form for 2 or more days before removing forms.

3.3 HISTORIC CONCRETE CRACK PATCHING REPAIR

- A. Clean entirety of the shaft per spec section 030301
- B. Verify exist. crack width cracks greater than 15 mils shall be repaired. Cracks smaller than 15 mils shall remain undertreated.
- C. Remove all loose concrete around existing crack.

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- D. If exposed rebar is present within crack, repair per concrete spalling notes.
 - E. Verify extents of cracking and initiate a 3/4" deep routing around the extents of the crack going beyond each end of the crack a minimum of 1" per Structural Drawings
 - F. Existing concrete surface shall be clean, sound, and free of oil, grease, laitance, curing compounds, or any other foreign substance. Areas treated with product must be free of dust and any foreign matter prior to topping application.
 - G. Mixing Guidelines: Approximately 3 to 4 qt of water is required to mix 50 lb of product for patching applications. Slowly mix material into 3 qt of water and adjust water to desired consistency. Inconsistent water/cement ration will affect color. Do not exceed 4 qt of water.
 - H. Trowel apply. Apply to a clean, dry, sound substrate above 40° F. Rub or scratch part of the mixed material onto surface just prior to application. Do not allow rub or scratch coat to dry before application. Apply material within 15 to 20 minutes of mixing. Rub or scratch part of the mixed material onto surface just prior to application. Material is to be color matched to existing concrete per architectural requirements within mock-up notes on sheet a1.2.
 - I. Curing. Rapid drying of cement-based products may cause cracking or de-bonding. Avoid are placing concrete in these conditions, damp cure for 1 to 3 days. Curing compounds, wet burlap or polyethylene will reduce rapid drying but may cause color change or mar product burlap or polyethylene will reduce rapid drying but may cause color change or mar product surface
- 3.4 CONCRETE STRUCTURAL MEMBER REPAIR
- 3.5 CONCRETE SURFACE REPAIR USING CEMENTITIOUS MATERIALS
- 3.6 FIELD QUALITY CONTROL
- A. See Section 014000 - Quality Requirements for additional requirements.
 - B. An independent testing agency, as specified in Section 014000, will perform field inspection and testing.
 - C. Field Quality Control for CFRP:
 - 1. Inspect installation and test for compliance with ICC-ES AC178.
 - 2. Inspect for voids, bubbles, and delaminations by performing a visual and acoustic tap test of layered surface after 24 hours of initial resin saturant cure.
 - 3. Test for material properties of CFRP in accordance with ASTM D3039/D3039M.
 - 4. Nonconforming Work: Repair defective work after minimum cure time for CFRP laminates.
- 3.7 UNIT PRICING
- A. Provide accounting for square foot or spall repair and lineal foot or crack repair. Refer to DRAWINGS AND SPECIFICATION 012200.
- END OF SECTION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes historic treatment work consisting of cleaning historic cast-in-place concrete surfaces to remove surface dirt, atmospheric pollutants, metallic stains, grease stains, and paint. Cleaning methods include low- and medium-pressure washing with cold and warm potable water, with and without chemical solutions, for general surface cleaning. Cleaning methods also include the application of chemical applications and poulticing for removal of metallic stains, grease stains, paint, and graffiti, if required.
- B. Section includes preconstruction procedures for determining the gentlest and least invasive method of cleaning historic cast-in-place surfaces to an acceptable aesthetic appearance without contributing to their further deterioration.
- C. Related Requirements:
 - 1. Section 030100 "Maintenance of Concrete" for repair and rehabilitation treatments of cast-in-place concrete.
 - 2. Section 079200 "Joint Sealants" for new joint sealants for historic cast-in-place concrete.

1.3 UNIT PRICES

- A. Work of this Section is affected by unit prices specified in Section 012200 "Unit Prices."
 - 1. Unit prices apply to additions to and deletions from Work as authorized by Change Orders.

1.4 DEFINITIONS

- A. Very Low-Pressure Spray: Less than 100 psi (690 kPa).
- B. Low-Pressure Spray: 100 to 400 psi (690 to 2750 kPa).
- C. Medium-Pressure Spray: 400 to 800 psi (2750 to 5510 kPa).
- D. High-Pressure Spray: 800 to 1200 psi (5510 to 8250 kPa).

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference on historic cast-in-place concrete cleaning at General Contractor's field office at Project Site.
 - 1. Review minutes of Preliminary Historic Treatment Conference that pertain to cast-in-place historic treatment and cleaning.
 - 2. Review methods and procedures related to cleaning historic concrete, including, but not limited to, the following:
 - a. Historic treatment specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Erection sequencing, anchoring, and safety requirements of scaffolding, lifts and hoistways, if required.
 - c. Coordination of scaffolding, lifts and hoistways access and use for all applicable rehabilitation work.
 - d. Materials, material application, and sequencing.
 - e. Quality-control program.
 - f. Fire-protection plan.
 - g. Cleaning program.
 - h. Coordination with building and site occupants.

1.6 SEQUENCING AND SCHEDULING

- A. Work Sequence: Perform historic concrete cleaning work in the following sequence:
 - 1. Remove plant growth, equipment, conduits, and other obstructions.
 - 2. Inspect concrete for open expansion and construction joints. Where repairs are required, delay further cleaning work until after repairs are completed, cured, and dried to prevent the intrusion of water and other cleaning materials into historic cast-in-place concrete assemblies.

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3. Remove paint.
 4. Clean concrete.
 5. Where water repellents or graffiti-resistant coatings are to be used on or near concrete work, delay application of these chemicals until after cleaning.
- B. As scaffolding is removed, patch anchor holes used to attach scaffolding. Patch holes in concrete units according to historic concrete repair Sections.
- 1.7 ACTION SUBMITTALS
- A. Product Data: For each type of product.
 1. Include material descriptions and application instructions.
 2. Include test data substantiating that products comply with requirements.
- 1.8 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For historic treatment specialists, including field supervisors and workers, paint-remover manufacturer, and chemical-cleaner manufacturer.
 - B. Preconstruction Test Reports: For cleaning materials and methods.
 - C. Quality-control program.
 - D. Cleaning program.
- 1.9 QUALITY ASSURANCE
- A. Basis for Standard of Care: U.S. Department of the Interior – National Park Service – Standards and Guidelines and the City of San Antonio’s Historic Preservation Guidelines. Refer to the following publications available online (<https://www.nps.gov/orgs/1739/preservation-briefs.htm>) for additional information regarding best preservation practices in cleaning of historic cast-in-place concrete:
 1. “Preservation Brief Number 6: Dangers of Abrasive Cleaning to Historic Buildings.” Anne E. Grimmer. Cautions against the use of sandblasting to clean various buildings and suggests measures to mitigate the effects of improper cleaning. Explains the limited circumstances under which abrasive cleaning may be appropriate. 1979.
 2. “Preservation Brief Number 15: Preservation of Historic Concrete.” Paul Gaudette and Deborah Slaton. Discusses the characteristics of concrete and causes of deterioration. Includes information on cleaning, maintenance, and repair, and on protective systems. 2007. GPO stock number 024-005-01253-2.
 - B. Historic Treatment Specialist Qualifications: A qualified historic concrete cleaning specialist with at least seven years of experience with projects of similar scope and complexity. Experience cleaning new concrete work is insufficient experience for historic treatment work.
 - C. Paint-Remover Manufacturer Qualifications: A firm regularly engaged in producing concrete paint removers that have been used for similar applications with successful results, and with factory-authorized service representatives who are available for consultation and Project-site inspection, preconstruction product testing, and on-site assistance.
 - D. Chemical-Cleaner Manufacturer Qualifications: A firm regularly engaged in producing concrete cleaners that have been used for similar applications with successful results, and with factory-authorized service representatives who are available for consultation and Project-site inspection, preconstruction product testing, and on-site assistance.
 - E. Quality-Control Program: Prepare a written quality-control program for this Project to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging concrete. Include provisions for supervising performance and preventing damage.
 - F. Cleaning Program: Prepare a written cleaning program that describes cleaning process in detail, including materials, methods, sequence, and equipment to be used; protection of surrounding materials; and control of runoff during operations.
 1. If materials and methods other than those indicated are proposed for any phase of cleaning work, add to the quality-control program a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project.
 - G. Test Patches and Mockups: Prepare mockups of cleaning on existing surfaces to demonstrate aesthetic effects and to set quality standards for materials and execution.
 1. Cleaning: Clean an area approximately 16 sq. ft. (1.5 sq. m) for each type of concrete and surface condition.

- a. Test cleaners and methods on samples of adjacent materials for possible adverse reactions. Do not test cleaners and methods known to have deleterious effect.
 - b. Allow a waiting period of not less than seven days after completion of sample cleaning to permit a study of sample panels for negative reactions.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.10 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified historic treatment specialist or one or more chemical-cleaner and paint-remover manufacturers to perform preconstruction testing on concrete surfaces.
1. Use test areas where directed by Architect and representative of proposed materials and existing construction.

1.11 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit concrete cleaning work to be performed according to product manufacturers' written instructions and specified requirements.
- B. Clean concrete surfaces only when air temperature is 40 deg F (4 deg C) and above and is predicted to remain so for at least seven days after completion of cleaning.

1.12 WARRANTIES

- A. Cleaning Warranty: Cleaning procedures shall be warranted for a period of two years against harm to substrate (masonry and mortar) or to adjacent materials including, but not limited to, discoloration of substrate from improper procedures or usage, chemical damage from inadequate rinse procedures, and abrasive damage from improper procedures.

PART 2 PRODUCTS

2.1 EQUIPMENT AND TECHNIQUES DEMONSTRATION

- A. Demonstrate equipment and techniques of operation in an approved location and subject to approval.
- B. Dependable and sufficient equipment, appropriate and adequate to accomplish the work specified, shall be assembled at the work site in sufficient lead time before the start of the work to permit inspection, calibration of weighing and measuring devices, adjustment of parts, and the making of any repairs that may be required.
- C. Maintain the equipment in good working condition throughout the project.
- D. Cleaning equipment shall not cause staining, erosion, marring, or other damage or changes in the appearance of the surfaces to be cleaned.
- E. Sandblasting and high-pressure water cleaning equipment will not be allowed for cleaning historic cast-in-place concrete surfaces.
- F. Cleaning products that contain strong acids such as hydrochloric (muriatic) or hydrofluoric acid, which damage concrete and are harmful to persons, animals, site features, and the environment, will not be allowed for cleaning historic cast-in-place concrete surfaces.
- G. Water Cleaning:
1. Provide water cleaning equipment including a trailer-mounted water tank, pumps, high-pressure hose, wand with safety release cutoff control, nozzle, and auxiliary water resupply equipment.
 2. The equipment shall not be operated at a pressure which will cause etching or other damage to the masonry surface or mortar joints.
 3. Operate the equipment at a discharge capacity of 55 psi and 2.5 to 3 gpm for general surface cleaning operations.
 4. The water tank and auxiliary re-supply equipment shall be of sufficient capacity to permit continuous operations.
 5. Provide protective covers and barriers as required to prevent over-spray onto adjacent surfaces.
- H. Compressed air equipment shall deliver clean, oil and moisture free compressed air at the surface to be cleaned.

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1. The compressed air line shall have at least two in-line air filters to remove oil and moisture from the air supply. Test the compressed air supply during each shift for the presence of oil and moisture.
- 2.2 PAINT REMOVERS
- A. Low-Odor, Solvent-Type Paste Paint Remover: Manufacturer's standard low-odor, water-rinsable, solvent-type paste, gel, or foamed emulsion formulation for removing paint from concrete; and containing no methanol or methylene chloride.
 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABR Products, Inc.; ABR Citrus Paint Removers or Super Bio Strip Gel.
 - b. Cathedral Stone Products, Inc.; S-301, S-303 or S-305.
 - c. Dumond Chemicals, Inc.; Peel Away 7 without paper covering, Smart Strip, or Smart Strip Pro.
 - d. EaCo Chem, Inc.; InStrip.
 - e. PROSOCO, Inc.; Enviro Klean SafStrip, Enviro Klean SafStrip 8, or Sure Klean Graffiti Remover.
 2. Basis of Design Product: Sure Klean Graffiti Remover.
 - a. Manufacturer: PROSOCO, Inc., 3741 Greenway Circle, Lawrence, KS 66046. Phone: (800) 255-4255; Fax: (785) 830-9797. E-mail: CustomerCare@prosoco.com.
 - b. Product Description: Sure Klean Graffiti Remover is a low-odor, water-rinseable product to remove a variety of graffiti media from most smooth masonry, split-faced concrete block, wood and metal surfaces. Graffiti Remover does not contain methanol, methylene chloride or other halogenated solvents. Graffiti Remover is fully compliant with all known VOC (volatile organic compound) regulations.
 - c. Product Technical Data:
 - 1) Form: Clear, amber liquid with citrus odor
 - 2) Specific Gravity: 1.03
 - 3) pH: not applicable
 - 4) Weight/Gallon: 8.60 pounds
 - 5) Active Content: not applicable
 - 6) Total Solids: not applicable
 - 7) Voc Content: 30 percent maximum
 - 8) Flash Point: greater than 212 degrees F (greater than 100 degrees C) ASTM D3278
 - 9) Freeze Point: not applicable
 - 10) Shelf Life: 2 years in tightly sealed, unopened container
 - d. Product Limitations:
 - 1) Product efficiency is reduced during cold weather.
 - 2) May damage synthetic or reflective glass.
 - B. Covered, Solvent-Type Paste Paint Remover: Manufacturer's standard, low-odor, covered, water-rinsable, solvent-type paste or gel formulation for removing paint from masonry; and containing no methanol or methylene chloride.
 1. Basis-of-Design Products: Subject to compliance with requirements, PROSOCO, Inc.; Enviro Klean Safety Peel 1, or comparable product by one of the following:
 - a. Dumond Chemicals, Inc.; Peel Away 6 or Peel Away 7.
- 2.3 CLEANING MATERIALS
- A. Water: Potable.
 - B. Hot Water: Water heated to a temperature of 140 to 160 deg F (60 to 71 deg C).
 - C. Detergent Solution, Job Mixed: Solution prepared by mixing 2 cups (0.5 L) of tetrasodium pyrophosphate (TSPP), 1/2 cup (125 mL) of laundry detergent, and 20 quarts (20 L) of hot water for every 5 gal. (20 L) of solution required.
 - D. Mold, Mildew, and Algae Remover, Job Mixed: Solution prepared by mixing 2 cups (0.5 L) of tetrasodium pyrophosphate (TSPP), 5 quarts (5 L) of 5 percent sodium hypochlorite (bleach), and 15 quarts (15 L) of hot water for every 5 gal. (20 L) of solution required.

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- E. Nonacidic Gel Cleaner: Manufacturer's standard gel formulation, with pH between 6 and 9, that contains detergents with chelating agents and is specifically formulated for cleaning concrete surfaces.
1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dumond Chemicals, Inc.; Safe n' Easy Ultimate Stone and Masonry Cleaner.
 - b. Price Research, Ltd.; Price Marble Cleaner-Gel.
 - c. PROSOCO, Inc.; Sure Klean 942 Limestone & Marble Cleaner.
 - d. Approved equal.
 2. Basis of Design Product: PROSOCO, Inc. Sure Klean 942 Limestone & Marble Cleaner.
 - a. Manufacturer: PROSOCO, Inc., 3741 Greenway Circle, Lawrence, KS 66046. Phone: (800) 255-4255; Fax: (785) 830-9797. E-mail: CustomerCare@prosoco.com.
 - b. Product Description: Sure Klean® 942 Limestone & Marble Cleaner is a ready-to-use non-acidic cleaning gel. Designed for removing moderate-to-severe atmospheric staining, this low-odor gel cleaner is appropriate for use on exterior or interior masonry surfaces. Safe for use on most polished or unpolished marble and limestone surfaces, 942 Limestone & Marble Cleaner removes surface and subsurface staining, restoring surfaces to their original appearance.
 - c. Product Technical Data:
 - 1) Form: Clear amber gel with slight ammonia odor
 - 2) Specific Gravity: 1.040
 - 3) pH: 8.3
 - 4) Weight/Gallon: 8.65 pounds
 - 5) Active Content: not applicable
 - 6) Total Solids: not applicable
 - 7) Voc Content: not applicable
 - 8) Flash Point: greater than 200 degrees F (greater than 93 degrees C) ASTM D3278
 - 9) Freeze Point: 25 degrees Fahrenheit (-4 degrees Celsius) ASTM D 1177
 - 10) Shelf Life: 2 years in tightly sealed, unopened container
 - d. Product Limitations:
 - 1) May damage highly polished limestone or marble surfaces. Always test.
 - 2) Not for use in subfreezing temperatures. Gel will freeze.
 - 3) Surface and air temperatures should be at least 50° F (10° C). Cold temperatures will adversely affect the product's cleaning properties.
- F. Nonacidic Liquid Cleaner: Manufacturer's standard mildly alkaline liquid cleaner formulated for removing mold, mildew, and other organic soiling from ordinary building materials, including polished stone, brick, aluminum, plastics, and wood.
1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABR Products, Inc.; Building Wash 3.
 - b. Cathedral Stone Products, Inc.; D/2 Biological Solution.
 - c. Diedrich Technologies Inc., a division of Sandell Construction Solutions; Diedrich 910PM Polished Marble/Granite Cleaner.
 - d. Dumond Chemicals, Inc.; Safe n' Easy Architectural Cleaner/Restorer.
 - e. Hydrochemical Techniques, Inc.; HydroClean HT-700 Polished Marble & Granite Cleaner.
 - f. Price Research, Ltd.; Price Non-Acid Masonry Cleaner.
 - g. PROSOCO, Inc.; Enviro Klean 2010 All Surface Cleaner.
 - h. Approved equal.
 2. Basis of Design Product: PROSOCO, Inc. Enviro Klean 2010 All Surface Cleaner.
 - a. Manufacturer: PROSOCO, Inc., 3741 Greenway Circle, Lawrence, KS 66046. Phone: (800) 255-4255; Fax: (785) 830-9797. E-mail: CustomerCare@prosoco.com.

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- b. Product Description: Enviro Klean 2010 All Surface Cleaner is a mildly alkaline product for cleaning and degreasing light-to-heavily soiled stone, tile, and masonry. It contains no harsh acids, caustics or solvents. EK 2010 is concentrated for the toughest industrial cleaning jobs on concrete, metal and many other plant and warehouse surfaces but dilutable for home-use on windows, bathroom tub and tile, countertops and more.
 - c. Product Technical Data:
 - 1) Form: Clear Green liquid, fresh odor
 - 2) Specific Gravity: 1.07
 - 3) pH: 10.5; typical rinse water 7.8 to 8.2
 - 4) Weight/Gallon: 8.90 pounds
 - 5) Active Content: not applicable
 - 6) Total Solids: not applicable
 - 7) Voc Content: not applicable
 - 8) Flash Point: greater than 200 degrees F (greater than 93 degrees C) ASTM D3278
 - 9) Freeze Point: 32 degrees Fahrenheit (0 degrees Celsius)
 - 10) Shelf Life: 3 years in tightly sealed, unopened container
 - d. Product Limitations:
 - 1) Repeated use may dull polished carbonate surfaces, including but not limited to limestone, marble, and travertine.
- G. Mild-Acid Cleaner: Manufacturer's standard mild-acid cleaner containing no muriatic (hydrochloric), hydrofluoric, or sulfuric acid; or ammonium bifluoride or chlorine bleaches.
- 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABR Products, Inc.; X-190 Limestone & Concrete Cleaner.
 - b. Diedrich Technologies Inc., a division of Sandell Construction Solutions; Diedrich Envirorestore 100 or Diedrich 910 Marble Cleaner.
 - c. PROSOCO, Inc.; Enviro Klean BioWash or Sure Klean Light Duty Restoration Cleaner.
 - d. Approved equal.
 - 2. Basis of Design Product: PROSOCO, Inc. Sure Klean Light Duty Concrete Cleaner.
 - a. Manufacturer: PROSOCO, Inc., 3741 Greenway Circle, Lawrence, KS 66046. Phone: (800) 255-4255; Fax: (785) 830-9797. E-mail: CustomerCare@prosoco.com.
 - b. Product Description: Sure Klean® Light Duty Concrete Cleaner is specially formulated to remove common construction and atmospheric staining from a variety of substrates, including smooth architectural and engineered concrete, custom masonry, concrete brick, manufactured stone and decorative pavers. The non-etching acidic cleaner removes rust, mud, atmospheric dirt, mortar smears and other stains without altering the surface texture.
 - c. Product Technical Data:
 - 1) Form: Clear, colorless liquid with slight odor
 - 2) Specific Gravity: 1.129
 - 3) pH: 1:14 at 1:2 dilution; 1:28 at 1:6 dilution
 - 4) Weight/Gallon: 9.39 pounds
 - 5) Active Content: not applicable
 - 6) Total Solids: not applicable
 - 7) Voc Content: not applicable
 - 8) Flash Point: not applicable
 - 9) Freeze Point: 12 degrees Fahrenheit (-11 degrees Celsius)
 - 10) Shelf Life: 3 years in tightly sealed, unopened container
 - d. Product Limitations:
 - 1) Acidic contents may damage polished masonry, some non-masonry, and acid-sensitive surfaces vitrine.

- 2) May remove some surface-applied accent colors. Always test to confirm suitability and results before overall application.
- 3) May damage treated low-E glass; acrylic and polycarbonate sheet glazing; and glazing with surface-applied reflective, metallic, or other synthetic coatings and films. Always test for adverse effects prior to overall application. If testing is not feasible or indicates adverse effects, such substrates must be protected.

2.4 POULTICES

- A. General Stain Remover Poultice: Manufacturer's standard, non-acidic, ready-to-use, low-odor poultice paste for general stain removal and deep-seated oil, dirt, harmful salts and other embedded stains out of sensitive masonry and concrete surfaces.
 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. PROSOCO, Inc.; Sure Klean 1260 Limestone & Marble Poultice.
 - b. Approved equal.
- B. Metallic Salt Stain Remover Poultice: Manufacturer's standard, two-part, metallic stain remover designed to solubilize deep-seated copper sulfate and other metallic salts and draw staining elements out of masonry and concrete surfaces.
 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. PROSOCO, Inc.; Copper Stain Remover Poultice Cleaning System (Parts A and B).
 - b. PROSOCO, Inc.; Iron Stain Remover Poultice Cleaning System (Poultice Additive with PROSOCO's Marble Poultice).
 - c. Approved equal.
- C. Oil and Grease Stain Remover Poultice: Manufacturer's standard non-acidic, ready-to-use, low-odor poultice cleaner for stubborn stain removal of motor oil, brake, power-steering fluids, anti-freeze, hydraulic fluids, cooking oils, food grease, and other oil-based stains.
 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Custom Building Products (CBP); Aqua Mix Poultice Stain Remover.
 - b. PROSOCO, Inc.; Oil & Grease Stain Remover Poultice.
 - c. StonePro; Wet Poultice Oil Stain Remover.
 - d. Approved equal.

2.5 ACCESSORY MATERIALS

- A. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, glazed masonry, and polished stone surfaces from damaging effects of acidic and alkaline concrete cleaners.
 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABR Products, Inc.; ABR Rubber Mask.
 - b. Price Research, Ltd.; Price Mask.
 - c. PROSOCO, Inc.; Sure Klean Strippable Masking.
- B. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:
 1. Previous effectiveness in performing the work involved.
 2. Minimal possibility of damaging exposed surfaces.
 3. Consistency of each application.
 4. Uniformity of the resulting overall appearance.
 5. Do not use products or tools that could do the following:
 - a. Remove, alter, or harm the present condition or future preservation of existing surfaces, including surrounding surfaces not in contract.
 - b. Leave residue on surfaces.

PART 3 EXECUTION

3.1 CLEANING CONCRETE, GENERAL

- A. Execute historic cast-in-place concrete cleaning treatments only after undertaking a complete evaluation and analysis of areas to be repaired. Identify and correct causes of concrete deterioration prior to implementing cleaning treatments.
- B. Historic materials shall not be damaged or marred in the process of cleaning. Selection of cleaning methods shall conform to ASTM E1857-97(2021). Cleaning of concrete surfaces shall mirror closely standards established for existing dimensional stone as established in ASTM C1515-20.
- C. Cleaning Appearance Standard: Cleaned surfaces are to have a uniform appearance as viewed from 20 feet (6 m) away by Architect.
- D. Temporarily caulk or otherwise protect open joints to prevent water and cleaner intrusion into the interior of the structure from pressure spraying.
- E. Protect non-masonry materials and severely deteriorated concrete by approved methods prior to initiation of cleaning operations.
- F. Concrete cleaning shall remove all organic and inorganic contaminants from the surface and pores of the substrate, returning the concrete to its natural color. Surfaces shall be evenly cleaned with no evidence of streaking or bleaching. The cleaning process shall not affect the density, porosity, or color of the concrete.
- G. Use the gentlest methods possible for cleaning historic masonry to achieve the desired results. Make test patches and mockups to determine a satisfactory cleaning result.
- H. Proceed with cleaning in an orderly manner; work from top to bottom of each hoist, lift and/or scaffold width and from one end of each elevation to the other. Ensure that dirty residues and rinse water do not wash over dry, cleaned surfaces. Perform cleaning in a manner which results in uniform coverage of all surfaces, including corners, projecting details, and interstices, and which produces an even effect without streaking or damage to masonry.
- I. The cleaning materials, equipment, and methods shall not result in staining, erosion, marring, or other damage to the surfaces of the structure. Following an initial inspection and evaluation of the structure and surfaces, give the structure a surface cleaning which shall be completed prior to start of repair work, and sampling and testing of mortars. The work shall provide for the complete cleaning of all exterior masonry surfaces of the structures, removing all traces of moss, dirt, and other contaminants to allow determination of the masonry's color and shades, finish and texture, and other properties.
- J. Following completion of the surface cleaning of the structure (or side of structure) the masonry shall be dried prior to the start of any repair work.
- K. The following sequence of methods shall be used to determine the least aggressive, effective cleaning method:
 1. Water with brushes.
 2. Water with mild soap and brushes.
 3. Water with sodium hypochlorite (household bleach) and brushes.
 4. Stronger chemical cleaners, only when above methods are determined to be ineffective by the Architect.
- L. Avoid the use of strong acidic chemical cleaners on concrete and other calcareous (calcium containing) materials.
- M. Specially formulated poultices, as specified, may be employed to address deep-seated stains caused by atmospheric pollutants, biological growth, metallic salts, or petroleum products. Coordinate application of poultices with the Architect.
- N. Use only those cleaning methods indicated for each concrete material, condition, and location.
 1. Brushes: Do not use wire brushes or brushes that are not resistant to chemical cleaner being used.
 2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that cleaning methods do not damage concrete.
 - a. Equip units with pressure gauges.

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- b. For chemical-cleaner spray application, use low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with nozzle having a cone-shaped spray.
 - c. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
 - d. For high-pressure water-spray application, use fan-shaped spray that disperses water at an angle of at least 40 degrees.
 - e. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F (60 and 71 deg C) at flow rates indicated.
 - f. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging concrete surfaces. Keep wall wet below area being cleaned to prevent streaking from runoff.
- O. Perform additional general cleaning, paint and stain removal, and spot cleaning of small areas that are noticeably different when viewed according to the "Cleaning Appearance Standard" Paragraph above, so that cleaned surfaces blend smoothly into surrounding areas.
- P. Water Application Methods:
- 1. Water-Soak Application: Soak concrete surfaces by applying water continuously and uniformly to limited area for time indicated. Apply water at low pressures and low volumes in multiple fine sprays using perforated hoses or multiple spray nozzles. Erect a protective enclosure constructed of polyethylene sheeting to cover area being sprayed.
 - 2. Water-Spray Applications: Unless otherwise indicated, hold spray nozzle at least 12 inches (300 mm) from concrete surface, and apply water in horizontal back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.
- Q. Chemical-Cleaner Application Methods: Apply chemical cleaners to concrete surfaces according to chemical-cleaner manufacturer's written instructions. Do not allow chemicals to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.
- R. Rinse off chemical residue and soil by working upward from bottom to top of each treated area at each stage or scaffold setting. Periodically during each rinse, test pH of rinse water running off of cleaned area to determine that chemical cleaner is completely removed.
- 1. Apply neutralizing agent and repeat rinse if necessary to produce tested pH of between 6.7 and 7.5.
- S. After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.
- 3.2 TEST PATCHES AND MOCKUPS
- A. Demonstrate the materials, equipment, and methods to be used in cleaning in a test section approximately 4 by 4 ft square.
 - B. The location of the test section, and the completed test section shall be subject to approval by the Architect. Adjust the cleaning process as required and the test section rerun until an acceptable process is obtained. Test patches shall be in inconspicuous areas of the building.
 - C. The areas tested shall exhibit soiling characteristics representative of those larger areas to be cleaned.
 - D. Allow tested areas to dry minimum of seven days before a determination is made on the effectiveness of a particular treatment by the Architect.
- 3.3 PRELIMINARY CLEANING
- A. Preliminary Cleaning: Before beginning general cleaning, remove extraneous substances that are resistant to planned cleaning methods. Extraneous substances include paint, calking, asphalt, and tar.
 - 1. Carefully remove heavy accumulations of rigid materials from concrete surface with sharp chisel. Do not scratch or chip concrete surface.
 - 2. Remove paint and calking with low-odor, solvent-type paste paint remover.
 - a. Comply with requirements in "Paint Removal" Article.
 - b. Repeat application up to two times if needed.
- 3.4 PRESSURE SPRAYING
- A. Spray apply water to masonry surfaces to comply with requirements indicated by test patches for location, purpose, water temperature, pressure, volume, and equipment.

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- B. Unless otherwise indicated, the surface washing shall be done with clean, low pressure water (pressure of less than 55 psi and 2.5 to 3 gpm discharge) and the spray nozzle shall not be held less than 12 inches from surface of masonry.
 - C. Water shall be applied side to side in overlapping bands to produce uniform coverage.
- 3.5 HANDSCRUBBING
- A. Pre-wetted surfaces shall be scrubbed using hand-held natural bristle or nylon brushes.
 - B. Wire brushes shall not be used. Brushes with natural bristles are preferred.
 - C. Surfaces to be cleaned shall be scrubbed to remove surface contaminants.
- 3.6 RINSING
- A. Scrubbed surfaces shall be rinsed clean of all contaminants and cleaning solutions with water in a low-to-moderate pressure spray, working upwards from bottom to top of each treated area.
 - B. The rinsing cycle shall remove all traces of contaminants and cleaning solutions.
- 3.7 PAINT REMOVAL
- A. Paint-Remover Application, General: Apply paint removers according to paint-remover manufacturer's written instructions. Do not allow paint removers to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.
 - B. Paint Removal with Solvent-Type Paste Paint Remover:
 - 1. Before applying, read the Manufacturer's Product Data Sheet for Paint Remover. Use as packaged. Do not dilute or alter.
 - 2. Remove loose and peeling paint using low pressure water spray, scrapers, stiff natural-fiber bristle brushes, or a combination of these. Let surface dry thoroughly.
 - 3. Apply thick coating of paint remover to painted surface with natural-fiber cleaning brush, deep-nap roller, or large paint brush. Apply in one or two coats according to manufacturer's written instructions.
 - 4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
 - 5. Rinse with hot water applied by low pressure spray to remove chemicals and paint residue.
 - 6. Manufacturer's application notes:
 - a. Periodic agitation with a stiff bristle brush improves penetration. Some coatings will need multiple applications/increased dwell time.
 - b. Removal results may be unsatisfactory if Graffiti Remover dries on the surface. If testing indicates long dwell periods are required, reapply to prevent drying or use PROSOCO's Enviro Klean SafStrip or SafStrip 8.
 - c. Heavy graffiti staining may require more than one application.
 - C. Paint Removal with Covered, Solvent-Type Paste Paint Remover:
 - 1. Apply with a brush, roller, or trowel, 1/16" to 1/8" thick. Do not dilute or alter. Apply and prepare per manufacturer's instructions.
 - 2. Cover Safety Peel 1 with sheets of Enviro Klean OverCoat, printed side outward. Rub gently to remove air pockets and ensure smooth, overall adhesion.
 - 3. Let Safety Peel 1 and OverCoat dwell at least two hours before evaluating their effectiveness. Some types and thicknesses of coatings may need dwell times of up to 24 hours. Multiple applications may also be necessary.
 - 4. Remove and collect the paste, paper, and dissolved material by inserting a trowel, spatula or other paint scraping tool through the paste and lifting it from the surface. Remove as much as possible. Reapply as needed.
 - 5. Rinse surface clean with water, preferably heated water, to improve removal effectiveness. Let cleaned surface dry thoroughly before any other treatment is applied. If residual product has dried on the surface, wet it down with warm water and keep it moist for 15 minutes. This makes it easier to rinse thoroughly with a pressure washer.
 - 6. Dispose of paper, spent cleaner and dissolved coatings/contaminants according to local, state and federal regulations.
- 3.8 CLEANING CAST-IN-PLACE CONCRETE
- A. Cold-Water Soak:
 - 1. Continue spraying until surface encrustation has softened sufficiently to permit its removal by water wash, as indicated by cleaning tests.

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2. Remove soil and softened surface encrustation from surface with cold water applied by low-pressure spray.
 - B. Hot-Water Wash: Use hot water applied by low-pressure spray.
 - C. Detergent Cleaning:
 1. Wet surface with hot water applied by low-pressure spray.
 2. Scrub surface with detergent solution using medium-soft brushes until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.
 3. Rinse with hot water applied by low pressure spray to remove detergent solution and soil.
 4. Repeat cleaning procedure above, where required to produce cleaning effect established by mockup.
 - D. Mold, Mildew, and Algae Removal:
 1. Wet surface with hot water applied by low-pressure spray.
 2. Apply mold, mildew, and algae remover by brush or low-pressure spray.
 3. Scrub surface with medium-soft brushes until mold, mildew, and algae are thoroughly dislodged and can be removed by rinsing. Use small brushes for joints and crevices. Dip brush in mold, mildew, and algae remover often to ensure that adequate fresh cleaner is used and that surface remains wet.
 4. Rinse with hot water applied by low pressure spray to remove mold, mildew, and algae remover and soil.
 5. Repeat cleaning procedure above, where required to produce cleaning effect established by mockup.
 - E. Nonacidic Gel Chemical Cleaning:
 1. Wet surface with hot water applied by low-pressure spray.
 2. Apply gel cleaner in 1/8-inch (3-mm) thickness by brush, working into joints and crevices. Apply quickly and do not brush out excessively, so area is uniformly covered with fresh cleaner and dwell time is uniform throughout area being cleaned.
 3. Let cleaner remain on surface for period recommended in writing by chemical-cleaner manufacturer and established by mockup.
 4. Remove bulk of gel cleaner.
 5. Rinse with hot water applied by low pressure spray to remove chemicals and soil.
 6. Repeat cleaning procedure above, where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.
 - F. Nonacidic Liquid Chemical Cleaning:
 1. Wet surface with hot water applied by low-pressure spray.
 2. Apply cleaner to surface as directed by manufacturer with a brush or low-pressure spray.
 3. Let cleaner remain on surface for period recommended in writing by chemical-cleaner manufacturer and established by mockup.
 4. Rinse with hot water applied by low-pressure spray to remove chemicals and soil.
 5. Repeat cleaning procedure above, where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.
 - G. General Stain Remover Poulticing:
 1. Before applying, read "Preparation" and "Safety Information" sections in the Manufacturer's Product Data Sheet.
 - a. Do not dilute or alter; apply as packaged.
 - b. Refer to test area results for the optimal dwell period.
 2. Apply poultice to a dry surface one-eighth (1/8) to one-quarter inch (1/4) thick using a trowel or airless sprayer or other suitable applicator.
 3. Cover the poultice with Manufacturer's protective paper. Press the protective paper against the poultice. It will cling to the surface. Tape/seal off the edges of the paper.
 4. Leave the covered poultice on the surface 12 to 24 hours.
 5. Remove protective paper. If the poultice is still wet, allow the poultice to dry 2 to 4 hours. The poultice surface develops cracks as it contracts and dries. A fully developed network of cracks indicates the poultice is completely dry.
 6. Remove the poultice and captured contaminants. Insert a corrosion-resistant spatula, trowel or other suitable scraping device under the paste and carefully lift from the surface. Remove as much residue as possible.
 7. Rinse the surface thoroughly with fresh water, using a sponge, soft cloth or low pressure/low volume water-rinsing equipment.

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8. Repeat application as needed.
 9. Clean tools and equipment using fresh water.
- H. Metallic Salt Stain Remover Poulticing:
1. Before applying, read "Preparation" and "Safety Information" sections in the Manufacturer's Product Data Sheet.
 - a. Refer to Manufacturer's instructions for dilution and mixing of two-part stain remover poulticing product.
 - b. Refer to test area results for the optimal dwell period.
 2. Using a plasterer's trowel or soft-fibered brush, apply a 1/8 to 1/4 inch thick coating of the poultice mixture over the stained area. Poultice should cling to vertical surfaces.
 3. Allow poultice to remain on the surface for 24 hours or until completely dry. If cleaner is left on the surface unattended, cover the poultice with Manufacturer's protective paper, glossy side down. Press the protective paper against poultice. It will cling to the surface. Rub gently to remove air pockets and ensure smooth, overall adhesion. Tape/seal off edges of the film. Allow to dwell.
 4. Remove protective paper, if used. Allow the poultice to dry completely, 2–4 hours. The poultice surface develops cracks as it contracts and dries. A fully developed network of cracks indicates the poultice is completely dry. Dry times may vary with environmental conditions such as temperature, wind and humidity.
 5. Scrape dry poultice from the surface.
 6. Water-rinse the treated area using a soft-fibered brush to remove all poultice residue.
 7. Reapplication may be necessary on severely stained areas.
 8. Clean tools and equipment using fresh water.
- I. Oil and Grease Stain Remover Poulticing:
1. Before applying, read "Preparation" and "Safety Information" sections in the Manufacturer's Product Data Sheet.
 - a. Do not dilute or alter; apply as packaged.
 - b. Refer to test area results for the optimal dwell period.
 - c. Consult Manufacturer's representative for recommendations for poulticing vertical surfaces with specified product.
 2. Scrape debris and buildup from surface. Do not pre-wet.
 3. Shake product container well. Pour onto the stained surface until it completely covers the stain. Pour onto the stained surface until it exceeds the boundaries of the stain by at least one inch.
 4. Let the poultice dry for 5 to 8 hours overnight. Protect from pedestrian traffic and rain during dwell period. Dry times may vary with environmental conditions such as temperature, wind and humidity. The poultice surface develops cracks as it contracts and dries. A fully developed network of cracks indicates the poultice is completely dry.
 5. Sweep up the dry powder and dispose. On porous substrates, pressure water rinsing may facilitate removal of poultice residue.
 6. Cleanup: Brush-out brooms and wipe down dustpans with a damp cloth. High-pressure air may also be used to remove dust residues from brooms, brushes and dustpans.
- 3.9 FINAL CLEANING
- A. Clean adjacent non-concrete surfaces of spillage and debris. Use detergent and soft brushes or cloths, as necessary.
 - B. Remove masking materials, leaving no residues that could trap dirt.
- 3.10 FIELD QUALITY CONTROL
- A. Architect's Project Representatives: Architect will assign Project representatives to help carry out Architect's responsibilities at the site, including observing progress and quality of portion of the Work completed. Allow Architect's Project representatives use of lift devices and scaffolding, as needed, to observe progress and quality of portion of the Work completed.
 - B. Notify Architect's Project representatives in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until Architect's Project representatives have had reasonable opportunity to make observations of work areas at lift device or scaffold location.

- C. Manufacturer's Field Service: Engage paint-remover manufacturer's and chemical-cleaner manufacturer's factory-authorized service representatives for consultation and Project-site inspection and provide on-site assistance when requested by Architect. Have paint-remover manufacturer's and chemical-cleaner manufacturer's factory-authorized service representatives visit Project site not less than twice to observe progress and quality of the Work.

END OF SECTION

SECTION 03 03 01.16 – HISTORIC CAST-IN-PLACE CONCRETE CLEANING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes historic treatment work consisting of cleaning historic cast-in-place concrete surfaces to remove surface dirt, atmospheric pollutants, metallic stains, grease stains, and paint. Cleaning methods include low- and medium-pressure washing with cold and warm potable water, with and without chemical solutions, for general surface cleaning. Cleaning methods also include the application of chemical applications and poulticing for removal of metallic stains, grease stains, paint, and graffiti, if required.
- B. Section includes preconstruction procedures for determining the gentlest and least invasive method of cleaning historic cast-in-place surfaces to an acceptable aesthetic appearance without contributing to their further deterioration.
- C. Related Requirements:
1. Section 03 01 00 "Historic Concrete Repairs" for repair and rehabilitation treatments of cast-in-place concrete.
 2. Section 07 92 00 "Joint Sealants" for new joint sealants for historic cast-in-place concrete.

1.3 UNIT PRICES

- A. Work of this Section is affected by unit prices specified in Section 012200 "Unit Prices."
1. Unit prices apply to additions to and deletions from Work as authorized by Change Orders.

1.4 DEFINITIONS

- A. Very Low-Pressure Spray: Less than 100 psi (690 kPa).
- B. Low-Pressure Spray: 100 to 400 psi (690 to 2750 kPa).
- C. Medium-Pressure Spray: 400 to 800 psi (2750 to 5510 kPa).
- D. High-Pressure Spray: 800 to 1200 psi (5510 to 8250 kPa).

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference on historic cast-in-place concrete cleaning at General Contractor's field office at Project Site.
1. Review minutes of Preliminary Historic Treatment Conference that pertain to cast-in-place historic treatment and cleaning.
 2. Review methods and procedures related to cleaning historic concrete, including, but not limited to, the following:
 - a. Historic treatment specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, material application, sequencing, tolerances, and required clearances.
 - c. Site access requirements and hours of operations.
 - d. Erection sequencing, anchoring, and safety requirements of scaffolding, lifts and hoistways, if required.
 - e. Coordination of scaffolding, lifts and hoistways access and use for all applicable rehabilitation work.

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- f. Fire-protection plan.
 - g. Historic cast-in-place concrete historic treatment program
 - h. Quality-control program.
 - i. Coordination with building occupants.
 - j. Coordination with other trades working in close proximity to historic wood doors who may impact the work, or may be impacted by the work, including shared use of scaffolding.
 - k. Review safety precautions and requirements due to unique site conditions:
 - 1) Work within and under City Public Service (CPS) utility easements.
 - 2) Potential road lane and sidewalk closures to permit erection of scaffolding.

1.6 SEQUENCING AND SCHEDULING

- A. Work Sequence: Perform historic concrete cleaning work in the following sequence:
 - 1. Remove plant growth, equipment, conduits, and other obstructions.
 - 2. Inspect concrete for open expansion and construction joints. Where repairs are required, delay further cleaning work until after repairs are completed, cured, and dried to prevent the intrusion of water and other cleaning materials into historic cast-in-place concrete assemblies.
 - 3. Remove paint.
 - 4. Clean concrete.
 - 5. Where water repellents or graffiti-resistant coatings are to be used on or near concrete work, delay application of these chemicals until after cleaning.
- B. As scaffolding is removed, patch anchor holes used to attach scaffolding. Patch holes in concrete units according to historic concrete repair Sections.

1.7 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include material descriptions and application instructions.
 - 2. Include test data substantiating that products comply with requirements.

1.8 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For historic treatment specialists, including field supervisors and workers, paint-remover manufacturer, and chemical-cleaner manufacturer.
- B. Preconstruction Test Reports: For cleaning materials and methods.
- C. Quality-control program.
- D. Cleaning program.

1.9 QUALITY ASSURANCE

- A. Basis for Standard of Care: U.S. Department of the Interior – National Park Service – Standards and Guidelines and the City of San Antonio’s Historic Preservation Guidelines. Refer to the following publications available online (<https://www.nps.gov/orgs/1739/preservation-briefs.htm>) for additional information regarding best preservation practices in cleaning of historic cast-in-place concrete:
 - 1. “Preservation Brief Number 6: Dangers of Abrasive Cleaning to Historic Buildings.” Anne E. Grimmer. Cautions against the use of sandblasting to clean various buildings and suggests measures to mitigate the effects of improper cleaning. Explains the limited circumstances under which abrasive cleaning may be appropriate. 1979.
 - 2. “Preservation Brief Number 15: Preservation of Historic Concrete.” Paul Gaudette and Deborah Slaton. Discusses the characteristics of concrete and causes of deterioration. Includes information on cleaning, maintenance, and repair, and on protective systems. 2007. *GPO stock number 024-005-01253-2*.

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- B. Historic Treatment Specialist Qualifications: A qualified historic concrete cleaning specialist with at least seven years of experience with projects of similar scope and complexity. Experience cleaning new concrete work is insufficient experience for historic treatment work.
 - C. Paint-Remover Manufacturer Qualifications: A firm regularly engaged in producing concrete paint removers that have been used for similar applications with successful results, and with factory-authorized service representatives who are available for consultation and Project-site inspection, preconstruction product testing, and on-site assistance.
 - D. Chemical-Cleaner Manufacturer Qualifications: A firm regularly engaged in producing concrete cleaners that have been used for similar applications with successful results, and with factory-authorized service representatives who are available for consultation and Project-site inspection, preconstruction product testing, and on-site assistance.
 - E. Quality-Control Program: Prepare a written quality-control program for this Project to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging concrete. Include provisions for supervising performance and preventing damage.
 - F. Cleaning Program: Prepare a written cleaning program that describes cleaning process in detail, including materials, methods, sequence, and equipment to be used; protection of surrounding materials; and control of runoff during operations.
 - 1. If materials and methods other than those indicated are proposed for any phase of cleaning work, add to the quality-control program a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project.
 - G. Test Patches and Mockups: Prepare mockups of cleaning on existing surfaces to demonstrate aesthetic effects and to set quality standards for materials and execution.
 - 1. Cleaning: Clean an area approximately 16 sq. ft. (1.5 sq. m) for each type of concrete and surface condition.
 - a. Test cleaners and methods on samples of adjacent materials for possible adverse reactions. Do not test cleaners and methods known to have deleterious effect.
 - b. Allow a waiting period of not less than seven days after completion of sample cleaning to permit a study of sample panels for negative reactions.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
- 1.10 PRECONSTRUCTION TESTING
- A. Preconstruction Testing Service: Engage a qualified historic treatment specialist or one or more chemical-cleaner and paint-remover manufacturers to perform preconstruction testing on concrete surfaces.
 - 1. Use test areas where directed by Architect and representative of proposed materials and existing construction.
- 1.11 FIELD CONDITIONS
- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit concrete cleaning work to be performed according to product manufacturers' written instructions and specified requirements.
 - B. Clean concrete surfaces only when air temperature is 40 deg F (4 deg C) and above and is predicted to remain so for at least seven days after completion of cleaning.
- 1.12 WARRANTIES
- A. Cleaning Warranty: Cleaning procedures shall be warranted for a period of two years against harm to substrate (masonry and mortar) or to adjacent materials including, but not limited to, discoloration of substrate from improper procedures or usage, chemical damage from inadequate rinse procedures, and abrasive damage from improper procedures.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND TECHNIQUES DEMONSTRATION

- A. Demonstrate equipment and techniques of operation in an approved location and subject to approval.
- B. Dependable and sufficient equipment, appropriate and adequate to accomplish the work specified, shall be assembled at the work site in sufficient lead time before the start of the work to permit inspection, calibration of weighing and measuring devices, adjustment of parts, and the making of any repairs that may be required.
- C. Maintain the equipment in good working condition throughout the project.
- D. Cleaning equipment shall not cause staining, erosion, marring, or other damage or changes in the appearance of the surfaces to be cleaned.
- E. Sandblasting and high-pressure water cleaning equipment will not be allowed for cleaning historic cast-in-place concrete surfaces.
- F. Cleaning products that contain strong acids such as hydrochloric (muriatic) or hydrofluoric acid, which damage concrete and are harmful to persons, animals, site features, and the environment, will not be allowed for cleaning historic cast-in-place concrete surfaces.
- G. Water Cleaning:
 - 1. Provide water cleaning equipment including a trailer-mounted water tank, pumps, high-pressure hose, wand with safety release cutoff control, nozzle, and auxiliary water resupply equipment.
 - 2. The equipment shall not be operated at a pressure which will cause etching or other damage to the masonry surface or mortar joints.
 - 3. Operate the equipment at a discharge capacity of 55 psi and 2.5 to 3 gpm for general surface cleaning operations.
 - 4. The water tank and auxiliary re-supply equipment shall be of sufficient capacity to permit continuous operations.
 - 5. Provide protective covers and barriers as required to prevent over-spray onto adjacent surfaces.
- H. Compressed air equipment shall deliver clean, oil and moisture free compressed air at the surface to be cleaned.
 - 1. The compressed air line shall have at least two in-line air filters to remove oil and moisture from the air supply. Test the compressed air supply during each shift for the presence of oil and moisture.

2.2 PAINT REMOVERS

- A. Low-Odor, Solvent-Type Paste Paint Remover: Manufacturer's standard low-odor, water-rinsable, solvent-type paste, gel, or foamed emulsion formulation for removing paint from concrete; and containing no methanol or methylene chloride.
 - 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABR Products, Inc.; ABR Citrus Paint Removers or Super Bio Strip Gel.
 - b. Cathedral Stone Products, Inc.; S-301, S-303 or S-305.
 - c. Dumond Chemicals, Inc.; Peel Away 7 without paper covering, Smart Strip, or Smart Strip Pro.
 - d. EaCo Chem, Inc.; InStrip.
 - e. PROSOCO, Inc.; Enviro Klean SafStrip, Enviro Klean SafStrip 8, or Sure Klean Graffiti Remover.
 - 2. Basis of Design Product: Sure Klean Graffiti Remover.
 - a. Manufacturer: PROSOCO, Inc., 3741 Greenway Circle, Lawrence, KS 66046. Phone: (800) 255-4255; Fax: (785) 830-9797. E-mail: CustomerCare@prosoco.com.

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- b. Product Description: Sure Klean Graffiti Remover is a low-odor, water-rinseable product to remove a variety of graffiti media from most smooth masonry, split-faced concrete block, wood and metal surfaces. Graffiti Remover does not contain methanol, methylene chloride or other halogenated solvents. Graffiti Remover is fully compliant with all known VOC (volatile organic compound) regulations.
 - c. Product Technical Data:
 - 1) Form: Clear, amber liquid with citrus odor
 - 2) Specific Gravity: 1.03
 - 3) pH: not applicable
 - 4) Weight/Gallon: 8.60 pounds
 - 5) Active Content: not applicable
 - 6) Total Solids: not applicable
 - 7) Voc Content: 30 percent maximum
 - 8) Flash Point: greater than 212 degrees F (greater than 100 degrees C) ASTM D3278
 - 9) Freeze Point: not applicable
 - 10) Shelf Life: 2 years in tightly sealed, unopened container
 - d. Product Limitations:
 - 1) Product efficiency is reduced during cold weather.
 - 2) May damage synthetic or reflective glass.
- B. Covered, Solvent-Type Paste Paint Remover: Manufacturer's standard, low-odor, covered, water-rinsable, solvent-type paste or gel formulation for removing paint from masonry; and containing no methanol or methylene chloride.
- 1. Basis-of-Design Products: Subject to compliance with requirements, PROSOCO, Inc.; Enviro Klean Safety Peel 1, or comparable product by one of the following:
 - a. Dumond Chemicals, Inc.; Peel Away 6 or Peel Away 7.

2.3 CLEANING MATERIALS

- A. Water: Potable.
- B. Hot Water: Water heated to a temperature of 140 to 160 deg F (60 to 71 deg C).
- C. Detergent Solution, Job Mixed: Solution prepared by mixing 2 cups (0.5 L) of tetrasodium pyrophosphate (TSPP), 1/2 cup (125 mL) of laundry detergent, and 20 quarts (20 L) of hot water for every 5 gal. (20 L) of solution required.
- D. Mold, Mildew, and Algae Remover, Job Mixed: Solution prepared by mixing 2 cups (0.5 L) of tetrasodium pyrophosphate (TSPP), 5 quarts (5 L) of 5 percent sodium hypochlorite (bleach), and 15 quarts (15 L) of hot water for every 5 gal. (20 L) of solution required.
- E. Nonacidic Gel Cleaner: Manufacturer's standard gel formulation, with pH between 6 and 9, that contains detergents with chelating agents and is specifically formulated for cleaning concrete surfaces.
 - 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dumond Chemicals, Inc.; Safe n' Easy Ultimate Stone and Masonry Cleaner.
 - b. Price Research, Ltd.; Price Marble Cleaner-Gel.
 - c. PROSOCO, Inc.; Sure Klean 942 Limestone & Marble Cleaner.
 - d. Approved equal.
 - 2. Basis of Design Product: PROSOCO, Inc. Sure Klean 942 Limestone & Marble Cleaner.
 - a. Manufacturer: PROSOCO, Inc., 3741 Greenway Circle, Lawrence, KS 66046. Phone: (800) 255-4255; Fax: (785) 830-9797. E-mail: CustomerCare@prosoco.com.

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- b. Product Description: Sure Klean® 942 Limestone & Marble Cleaner is a ready-to-use non-acidic cleaning gel. Designed for removing moderate-to-severe atmospheric staining, this low-odor gel cleaner is appropriate for use on exterior or interior masonry surfaces. Safe for use on most polished or unpolished marble and limestone surfaces, 942 Limestone & Marble Cleaner removes surface and subsurface staining, restoring surfaces to their original appearance.
 - c. Product Technical Data:
 - 1) Form: Clear amber gel with slight ammonia odor
 - 2) Specific Gravity: 1.040
 - 3) pH: 8.3
 - 4) Weight/Gallon: 8.65 pounds
 - 5) Active Content: not applicable
 - 6) Total Solids: not applicable
 - 7) Voc Content: not applicable
 - 8) Flash Point: greater than 200 degrees F (greater than 93 degrees C) ASTM D3278
 - 9) Freeze Point: 25 degrees Fahrenheit (-4 degrees Celsius) ASTM D 1177
 - 10) Shelf Life: 2 years in tightly sealed, unopened container
 - d. Product Limitations:
 - 1) May damage highly polished limestone or marble surfaces. Always test.
 - 2) Not for use in subfreezing temperatures. Gel will freeze.
 - 3) Surface and air temperatures should be at least 50° F (10° C). Cold temperatures will adversely affect the product's cleaning properties.
- F. Nonacidic Liquid Cleaner: Manufacturer's standard mildly alkaline liquid cleaner formulated for removing mold, mildew, and other organic soiling from ordinary building materials, including polished stone, brick, aluminum, plastics, and wood.
- 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABR Products, Inc.; Building Wash 3.
 - b. Cathedral Stone Products, Inc.; D/2 Biological Solution.
 - c. Diedrich Technologies Inc., a division of Sandell Construction Solutions; Diedrich 910PM Polished Marble/Granite Cleaner.
 - d. Dumond Chemicals, Inc.; Safe n' Easy Architectural Cleaner/Restorer.
 - e. Hydrochemical Techniques, Inc.; HydroClean HT-700 Polished Marble & Granite Cleaner.
 - f. Price Research, Ltd.; Price Non-Acid Masonry Cleaner.
 - g. PROSOCO, Inc.; Enviro Klean 2010 All Surface Cleaner.
 - h. Approved equal.
 - 2. Basis of Design Product: PROSOCO, Inc. Enviro Klean 2010 All Surface Cleaner.
 - a. Manufacturer: PROSOCO, Inc., 3741 Greenway Circle, Lawrence, KS 66046. Phone: (800) 255-4255; Fax: (785) 830-9797. E-mail: CustomerCare@prosoco.com.
 - b. Product Description: Enviro Klean 2010 All Surface Cleaner is a mildly alkaline product for cleaning and degreasing light-to-heavily soiled stone, tile, and masonry. It contains no harsh acids, caustics or solvents. EK 2010 is concentrated for the toughest industrial cleaning jobs on concrete, metal and many other plant and warehouse surfaces but dilutable for home-use on windows, bathroom tub and tile, countertops and more.
 - c. Product Technical Data:
 - 1) Form: Clear Green liquid, fresh odor

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- 2) Specific Gravity: 1.07
 - 3) pH: 10.5; typical rinse water 7.8 to 8.2
 - 4) Weight/Gallon: 8.90 pounds
 - 5) Active Content: not applicable
 - 6) Total Solids: not applicable
 - 7) Voc Content: not applicable
 - 8) Flash Point: greater than 200 degrees F (greater than 93 degrees C) ASTM D3278
 - 9) Freeze Point: 32 degrees Fahrenheit (0 degrees Celsius)
 - 10) Shelf Life: 3 years in tightly sealed, unopened container
- d. Product Limitations:
- 1) Repeated use may dull polished carbonate surfaces, including but not limited to limestone, marble, and travertine.
- G. Mild-Acid Cleaner: Manufacturer's standard mild-acid cleaner containing no muriatic (hydrochloric), hydrofluoric, or sulfuric acid; or ammonium bifluoride or chlorine bleaches.
1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABR Products, Inc.; X-190 Limestone & Concrete Cleaner.
 - b. Diedrich Technologies Inc., a division of Sandell Construction Solutions; Diedrich Envirostore 100 or Diedrich 910 Marble Cleaner.
 - c. PROSOCO, Inc.; Enviro Klean BioWash or Sure Klean Light Duty Restoration Cleaner.
 - d. Approved equal.
 2. Basis of Design Product: PROSOCO, Inc. Sure Klean Light Duty Concrete Cleaner.
 - a. Manufacturer: PROSOCO, Inc., 3741 Greenway Circle, Lawrence, KS 66046. Phone: (800) 255-4255; Fax: (785) 830-9797. E-mail: CustomerCare@prosoco.com.
 - b. Product Description: Sure Klean® Light Duty Concrete Cleaner is specially formulated to remove common construction and atmospheric staining from a variety of substrates, including smooth architectural and engineered concrete, custom masonry, concrete brick, manufactured stone and decorative pavers. The non-etching acidic cleaner removes rust, mud, atmospheric dirt, mortar smears and other stains without altering the surface texture.
 - c. Product Technical Data:
 - 1) Form: Clear, colorless liquid with slight odor
 - 2) Specific Gravity: 1.129
 - 3) pH: 1:14 at 1:2 dilution; 1:28 at 1:6 dilution
 - 4) Weight/Gallon: 9.39 pounds
 - 5) Active Content: not applicable
 - 6) Total Solids: not applicable
 - 7) Voc Content: not applicable
 - 8) Flash Point: not applicable
 - 9) Freeze Point: 12 degrees Fahrenheit (-11 degrees Celsius)
 - 10) Shelf Life: 3 years in tightly sealed, unopened container
 - d. Product Limitations:
 - 1) Acidic contents may damage polished masonry, some non-masonry, and acid-sensitive surfaces vitrine.
 - 2) May remove some surface-applied accent colors. Always test to confirm suitability and results before overall application.

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- 3) May damage treated low-E glass; acrylic and polycarbonate sheet glazing; and glazing with surface-applied reflective, metallic, or other synthetic coatings and films. Always test for adverse effects prior to overall application. If testing is not feasible or indicates adverse effects, such substrates must be protected.

2.4 POULTICES

- A. General Stain Remover Poultice: Manufacturer's standard, non-acidic, ready-to-use, low-odor poultice paste for general stain removal and deep-seated oil, dirt, harmful salts and other embedded stains out of sensitive masonry and concrete surfaces.
 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. PROSOCO, Inc.; Sure Klean 1260 Limestone & Marble Poultice.
 - b. Approved equal.
- B. Metallic Salt Stain Remover Poultice: Manufacturer's standard, two-part, metallic stain remover designed to solubilize deep-seated copper sulfate and other metallic salts and draw staining elements out of masonry and concrete surfaces.
 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. PROSOCO, Inc.; Copper Stain Remover Poultice Cleaning System (Parts A and B).
 - b. PROSOCO, Inc.; Iron Stain Remover Poultice Cleaning System (Poultice Additive with PROSOCO's Marble Poultice).
 - c. Approved equal.
- C. Oil and Grease Stain Remover Poultice: Manufacturer's standard non-acidic, ready-to-use, low-odor poultice cleaner for stubborn stain removal of motor oil, brake, power-steering fluids, anti-freeze, hydraulic fluids, cooking oils, food grease, and other oil-based stains.
 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Custom Building Products (CBP); Aqua Mix Poultice Stain Remover.
 - b. PROSOCO, Inc.; Oil & Grease Stain Remover Poultice.
 - c. StonePro; Wet Poultice Oil Stain Remover.
 - d. Approved equal.

2.5 ACCESSORY MATERIALS

- A. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, glazed masonry, and polished stone surfaces from damaging effects of acidic and alkaline concrete cleaners.
 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABR Products, Inc.; ABR Rubber Mask.
 - b. Price Research, Ltd.; Price Mask.
 - c. PROSOCO, Inc.; Sure Klean Strippable Masking.
- B. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:
 1. Previous effectiveness in performing the work involved.
 2. Minimal possibility of damaging exposed surfaces.
 3. Consistency of each application.
 4. Uniformity of the resulting overall appearance.
 5. Do not use products or tools that could do the following:

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- a. Remove, alter, or harm the present condition or future preservation of existing surfaces, including surrounding surfaces not in contract.
 - b. Leave residue on surfaces.

PART 3 - EXECUTION

3.1 CLEANING CONCRETE, GENERAL

- A. Execute historic cast-in-place concrete cleaning treatments only after undertaking a complete evaluation and analysis of areas to be repaired. Identify and correct causes of concrete deterioration prior to implementing cleaning treatments.
- B. Historic materials shall not be damaged or marred in the process of cleaning. Selection of cleaning methods shall conform to ASTM E1857-97(2021). Cleaning of concrete surfaces shall mirror closely standards established for existing dimensional stone as established in ASTM C1515-20.
- C. Cleaning Appearance Standard: Cleaned surfaces are to have a uniform appearance as viewed from 20 feet (6 m) away by Architect.
- D. Temporarily caulk or otherwise protect open joints to prevent water and cleaner intrusion into the interior of the structure from pressure spraying.
- E. Protect non-masonry materials and severely deteriorated concrete by approved methods prior to initiation of cleaning operations.
- F. Concrete cleaning shall remove all organic and inorganic contaminants from the surface and pores of the substrate, returning the concrete to its natural color. Surfaces shall be evenly cleaned with no evidence of streaking or bleaching. The cleaning process shall not affect the density, porosity, or color of the concrete.
- G. Use the gentlest methods possible for cleaning historic masonry to achieve the desired results. Make test patches and mockups to determine a satisfactory cleaning result.
- H. Proceed with cleaning in an orderly manner; work from top to bottom of each hoist, lift and/or scaffold width and from one end of each elevation to the other. Ensure that dirty residues and rinse water do not wash over dry, cleaned surfaces. Perform cleaning in a manner which results in uniform coverage of all surfaces, including corners, projecting details, and interstices, and which produces an even effect without streaking or damage to masonry.
- I. The cleaning materials, equipment, and methods shall not result in staining, erosion, marring, or other damage to the surfaces of the structure. Following an initial inspection and evaluation of the structure and surfaces, give the structure a surface cleaning which shall be completed prior to start of repair work, and sampling and testing of mortars. The work shall provide for the complete cleaning of all exterior masonry surfaces of the structures, removing all traces of moss, dirt, and other contaminants to allow determination of the masonry's color and shades, finish and texture, and other properties.
- J. Following completion of the surface cleaning of the structure (or side of structure) the masonry shall be dried prior to the start of any repair work.
- K. The following sequence of methods shall be used to determine the least aggressive, effective cleaning method:
 - 1. Water with brushes.
 - 2. Water with mild soap and brushes.
 - 3. Water with sodium hypochlorite (household bleach) and brushes.
 - 4. Stronger chemical cleaners, only when above methods are determined to be ineffective by the Architect.
- L. Avoid the use of strong acidic chemical cleaners on concrete and other calcareous (calcium containing) materials.

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- M. Specially formulated poultices, as specified, may be employed to address deep-seated stains caused by atmospheric pollutants, biological growth, metallic salts, or petroleum products. Coordinate application of poultices with the Architect.
 - N. Use only those cleaning methods indicated for each concrete material, condition, and location.
 - 1. Brushes: Do not use wire brushes or brushes that are not resistant to chemical cleaner being used.
 - 2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that cleaning methods do not damage concrete.
 - 3. Equip units with pressure gauges.
 - 4. For chemical-cleaner spray application, use low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with nozzle having a cone-shaped spray.
 - 5. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
 - 6. For high-pressure water-spray application, use fan-shaped spray that disperses water at an angle of at least 40 degrees.
 - 7. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F (60 and 71 deg C) at flow rates indicated.
 - 8. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging concrete surfaces. Keep wall wet below area being cleaned to prevent streaking from runoff.
 - O. Perform additional general cleaning, paint and stain removal, and spot cleaning of small areas that are noticeably different when viewed according to the "Cleaning Appearance Standard" Paragraph above, so that cleaned surfaces blend smoothly into surrounding areas.
 - P. Water Application Methods:
 - 1. Water-Soak Application: Soak concrete surfaces by applying water continuously and uniformly to limited area for time indicated. Apply water at low pressures and low volumes in multiple fine sprays using perforated hoses or multiple spray nozzles. Erect a protective enclosure constructed of polyethylene sheeting to cover area being sprayed.
 - 2. Water-Spray Applications: Unless otherwise indicated, hold spray nozzle at least 12 inches (300 mm) from concrete surface, and apply water in horizontal back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.
 - Q. Chemical-Cleaner Application Methods: Apply chemical cleaners to concrete surfaces according to chemical-cleaner manufacturer's written instructions. Do not allow chemicals to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.
 - R. Rinse off chemical residue and soil by working upward from bottom to top of each treated area at each stage or scaffold setting. Periodically during each rinse, test pH of rinse water running off of cleaned area to determine that chemical cleaner is completely removed.
 - 1. Apply neutralizing agent and repeat rinse if necessary to produce tested pH of between 6.7 and 7.5.
 - S. After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

3.2 TEST PATCHES AND MOCKUPS

- A. Demonstrate the materials, equipment, and methods to be used in cleaning in a test section approximately 4 by 4 ft square.
- B. The location of the test section, and the completed test section shall be subject to approval by the Architect. Adjust the cleaning process as required and the test section rerun until an acceptable process is obtained. Test patches shall be in inconspicuous areas of the building.
- C. The areas tested shall exhibit soiling characteristics representative of those larger areas to be cleaned.

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- D. Allow tested areas to dry minimum of seven days before a determination is made on the effectiveness of a particular treatment by the Architect.

3.3 PRELIMINARY CLEANING

- A. Preliminary Cleaning: Before beginning general cleaning, remove extraneous substances that are resistant to planned cleaning methods. Extraneous substances include paint, calking, asphalt, and tar.
1. Carefully remove heavy accumulations of rigid materials from concrete surface with sharp chisel. Do not scratch or chip concrete surface.
 2. Remove paint and calking with low-odor, solvent-type paste paint remover.
 - a. Comply with requirements in "Paint Removal" Article.
 - b. Repeat application up to two times if needed.

3.4 PRESSURE SPRAYING

- A. Spray apply water to masonry surfaces to comply with requirements indicated by test patches for location, purpose, water temperature, pressure, volume, and equipment.
- B. Unless otherwise indicated, the surface washing shall be done with clean, low pressure water (pressure of less than 55 psi and 2.5 to 3 gpm discharge) and the spray nozzle shall not be held less than 12 inches from surface of masonry.
- C. Water shall be applied side to side in overlapping bands to produce uniform coverage.

3.5 HANDSCRUBBING

- A. Pre-wetted surfaces shall be scrubbed using hand-held natural bristle or nylon brushes.
- B. Wire brushes shall not be used. Brushes with natural bristles are preferred.
- C. Surfaces to be cleaned shall be scrubbed to remove surface contaminants.

3.6 RINSING

- A. Scrubbed surfaces shall be rinsed clean of all contaminants and cleaning solutions with water in a low-to-moderate pressure spray, working upwards from bottom to top of each treated area.
- B. The rinsing cycle shall remove all traces of contaminants and cleaning solutions.

3.7 PAINT REMOVAL

- A. Paint-Remover Application, General: Apply paint removers according to paint-remover manufacturer's written instructions. Do not allow paint removers to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.
- B. Paint Removal with Solvent-Type Paste Paint Remover:
1. Before applying, read the Manufacturer's Product Data Sheet for Paint Remover. Use as packaged. Do not dilute or alter.
 2. Remove loose and peeling paint using low pressure water spray, scrapers, stiff natural-fiber bristle brushes, or a combination of these. Let surface dry thoroughly.
 3. Apply thick coating of paint remover to painted surface with natural-fiber cleaning brush, deep- nap roller, or large paint brush. Apply in one or two coats according to manufacturer's written instructions.
 4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
 5. Rinse with hot water applied by low pressure spray to remove chemicals and paint residue.
 6. Manufacturer's application notes:
 - a. Periodic agitation with a stiff bristle brush improves penetration. Some coatings will need multiple applications/increased dwell time.
 - b. Removal results may be unsatisfactory if Graffiti Remover dries on the surface. If testing indicates long dwell periods are required, reapply to prevent drying or use PROSOCO's Enviro Klean SafStrip or SafStrip 8.

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- c. Heavy graffiti staining may require more than one application.
 - C. Paint Removal with Covered, Solvent-Type Paste Paint Remover:
 - 1. Apply with a brush, roller, or trowel, 1/16" to 1/8" thick. Do not dilute or alter. Apply and prepare per manufacturer's instructions.
 - 2. Cover Safety Peel 1 with sheets of Enviro Klean OverCoat, printed side outward. Rub gently to remove air pockets and ensure smooth, overall adhesion.
 - 3. Let Safety Peel 1 and OverCoat dwell at least two hours before evaluating their effectiveness. Some types and thicknesses of coatings may need dwell times of up to 24 hours. Multiple applications may also be necessary.
 - 4. Remove and collect the paste, paper, and dissolved material by inserting a trowel, spatula or other paint scraping tool through the paste and lifting it from the surface. Remove as much as possible. Reapply as needed.
 - 5. Rinse surface clean with water, preferably heated water, to improve removal effectiveness. Let cleaned surface dry thoroughly before any other treatment is applied. If residual product has dried on the surface, wet it down with warm water and keep it moist for 15 minutes. This makes it easier to rinse thoroughly with a pressure washer.
 - 6. Dispose of paper, spent cleaner and dissolved coatings/contaminants according to local, state and federal regulations.
- 3.8 CLEANING CAST-IN-PLACE CONCRETE
- A. Cold-Water Soak:
 - 1. Continue spraying until surface encrustation has softened sufficiently to permit its removal by water wash, as indicated by cleaning tests.
 - 2. Remove soil and softened surface encrustation from surface with cold water applied by low-pressure spray.
 - B. Hot-Water Wash: Use hot water applied by low-pressure spray.
 - C. Detergent Cleaning:
 - 1. Wet surface with hot water applied by low-pressure spray.
 - 2. Scrub surface with detergent solution using medium-soft brushes until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.
 - 3. Rinse with hot water applied by low pressure spray to remove detergent solution and soil.
 - 4. Repeat cleaning procedure above, where required to produce cleaning effect established by mockup.
 - D. Mold, Mildew, and Algae Removal:
 - 1. Wet surface with hot water applied by low-pressure spray.
 - 2. Apply mold, mildew, and algae remover by brush or low-pressure spray.
 - 3. Scrub surface with medium-soft brushes until mold, mildew, and algae are thoroughly dislodged and can be removed by rinsing. Use small brushes for joints and crevices. Dip brush in mold, mildew, and algae remover often to ensure that adequate fresh cleaner is used and that surface remains wet.
 - 4. Rinse with hot water applied by low pressure spray to remove mold, mildew, and algae remover and soil.
 - 5. Repeat cleaning procedure above, where required to produce cleaning effect established by mockup.
 - E. Nonacidic Gel Chemical Cleaning:
 - 1. Wet surface with hot water applied by low-pressure spray.
 - 2. Apply gel cleaner in 1/8-inch (3-mm) thickness by brush, working into joints and crevices. Apply quickly and do not brush out excessively, so area is uniformly covered with fresh cleaner and dwell time is uniform throughout area being cleaned.

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3. Let cleaner remain on surface for period recommended in writing by chemical-cleaner manufacturer and established by mockup.
 4. Remove bulk of gel cleaner.
 5. Rinse with hot water applied by low pressure spray to remove chemicals and soil.
 6. Repeat cleaning procedure above, where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.
- F. Nonacidic Liquid Chemical Cleaning:
1. Wet surface with hot water applied by low-pressure spray.
 2. Apply cleaner to surface as directed by manufacturer with a brush or low-pressure spray.
 3. Let cleaner remain on surface for period recommended in writing by chemical-cleaner manufacturer and established by mockup.
 4. Rinse with hot water applied by low-pressure spray to remove chemicals and soil.
 5. Repeat cleaning procedure above, where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.
- G. General Stain Remover Poulticing:
1. Before applying, read "Preparation" and "Safety Information" sections in the Manufacturer's Product Data Sheet.
 - a. Do not dilute or alter; apply as packaged.
 - b. Refer to test area results for the optimal dwell period.
 2. Apply poultice to a dry surface one-eighth (1/8) to one-quarter inch (1/4) thick using a trowel or airless sprayer or other suitable applicator.
 3. Cover the poultice with Manufacturer's protective paper. Press the protective paper against the poultice. It will cling to the surface. Tape/seal off the edges of the paper.
 4. Leave the covered poultice on the surface 12 to 24 hours.
 5. Remove protective paper. If the poultice is still wet, allow the poultice to dry 2 to 4 hours. The poultice surface develops cracks as it contracts and dries. A fully developed network of cracks indicates the poultice is completely dry.
 6. Remove the poultice and captured contaminants. Insert a corrosion-resistant spatula, trowel or other suitable scraping device under the paste and carefully lift from the surface. Remove as much residue as possible.
 7. Rinse the surface thoroughly with fresh water, using a sponge, soft cloth or low pressure/low volume water-rinsing equipment.
 8. Repeat application as needed.
 9. Clean tools and equipment using fresh water.
- H. Metallic Salt Stain Remover Poulticing:
1. Before applying, read "Preparation" and "Safety Information" sections in the Manufacturer's Product Data Sheet.
 - a. Refer to Manufacturer's instructions for dilution and mixing of two-part stain remover poulticing product.
 - b. Refer to test area results for the optimal dwell period.
 2. Using a plasterer's trowel or soft-fibered brush, apply a 1/8 to 1/4 inch thick coating of the poultice mixture over the stained area. Poultice should cling to vertical surfaces.
 3. Allow poultice to remain on the surface for 24 hours or until completely dry. If cleaner is left on the surface unattended, cover the poultice with Manufacturer's protective paper, glossy side down. Press the protective paper against poultice. It will cling to the surface. Rub gently to remove air pockets and ensure smooth, overall adhesion. Tape/seal off edges of the film. Allow to dwell.
 4. Remove protective paper, if used. Allow the poultice to dry completely, 2-4 hours. The poultice surface develops cracks as it contracts and dries. A fully developed network of cracks indicates

the poultice is completely dry. Dry times may vary with environmental conditions such as temperature, wind and humidity.

5. Scrape dry poultice from the surface.
6. Water-rinse the treated area using a soft-fibered brush to remove all poultice residue.
7. Reapplication may be necessary on severely stained areas.
8. Clean tools and equipment using fresh water.

I. Oil and Grease Stain Remover Poulticing:

1. Before applying, read "Preparation" and "Safety Information" sections in the Manufacturer's Product Data Sheet.
 - a. Do not dilute or alter; apply as packaged.
 - b. Refer to test area results for the optimal dwell period.
 - c. Consult Manufacturer's representative for recommendations for poulticing vertical surfaces with specified product.
2. Scrape debris and buildup from surface. Do not pre-wet.
3. Shake product container well. Pour onto the stained surface until it completely covers the stain. Pour onto the stained surface until it exceeds the boundaries of the stain by at least one inch.
4. Let the poultice dry for 5 to 8 hours overnight. Protect from pedestrian traffic and rain during dwell period. Dry times may vary with environmental conditions such as temperature, wind and humidity. The poultice surface develops cracks as it contracts and dries. A fully developed network of cracks indicates the poultice is completely dry.
5. Sweep up the dry powder and dispose. On porous substrates, pressure water rinsing may facilitate removal of poultice residue.
6. Cleanup: Brush-out brooms and wipe down dustpans with a damp cloth. High-pressure air may also be used to remove dust residues from brooms, brushes and dustpans.

3.9 FINAL CLEANING

- A. Clean adjacent non-concrete surfaces of spillage and debris. Use detergent and soft brushes or cloths, as necessary.
- B. Remove masking materials, leaving no residues that could trap dirt.

3.10 FIELD QUALITY CONTROL

- A. Architect's Project Representatives: Architect will assign Project representatives to help carry out Architect's responsibilities at the site, including observing progress and quality of portion of the Work completed. Allow Architect's Project representatives use of lift devices and scaffolding, as needed, to observe progress and quality of portion of the Work completed.
- B. Notify Architect's Project representatives in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until Architect's Project representatives have had reasonable opportunity to make observations of work areas at lift device or scaffold location.
- C. Manufacturer's Field Service: Engage paint-remover manufacturer's and chemical-cleaner manufacturer's factory-authorized service representatives for consultation and Project-site inspection and provide on-site assistance when requested by Architect. Have paint-remover manufacturer's and chemical-cleaner manufacturer's factory-authorized service representatives visit Project site not less than twice to observe progress and quality of the Work.

END OF SECTION 03 03 01.16

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Formwork for cast-in-place concrete, with shoring, bracing and anchorage.
- B. Openings for other work.
- C. Form accessories.
- D. Form stripping.

1.2 RELATED REQUIREMENTS

- A. Section 032000 - Concrete Reinforcing.
- B. Section 033000 - Cast-in-Place Concrete.
- C. Section 051200 - Structural Steel Framing: Placement of embedded steel anchors and plates in cast-in-place concrete.

1.3 REFERENCE STANDARDS

- A. ACI CODE-318 - Building Code Requirements for Structural Concrete and Commentary; 2019 (Reapproved 2022).
- B. ACI PRC-347 - Guide to Formwork for Concrete; 2014 (Reapproved 2021).
- C. ACI SPEC-117 - Specification for Tolerances for Concrete Construction and Materials; 2010 (Reapproved 2015).
- D. ACI SPEC-301 - Specifications for Concrete Construction; 2020.
- E. ASME A17.1 - Safety Code for Elevators and Escalators Includes Requirements for Elevators, Escalators, Dumbwaiters, Moving Walks, Material Lifts, and Dumbwaiters with Automatic Transfer Devices; 2019, with Errata (2021).
- F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2022.
- G. COE CRD-C 572 - Handbook for Concrete and Cement Corps of Engineers Specifications for Polyvinylchloride Waterstop; 1974.
- H. PS 1 - Structural Plywood; 2009 (Revised 2019).

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate pertinent dimensions, materials, bracing, and arrangement of joints and ties.
- C. Suspended One-way, Two-way and Removeable Panormwork Shop Drawings: Include calculations or selections from manufacturer's prescriptive design tables that indicate compliance with applicable building code and manufacturer's requirements.
 - 1. Include the design engineer's stamp or seal on each sheet of shop drawings.
- D. Shop Drawings: Indicate layout of prefabricated forms, including beams, drops and proposed concrete pour breaks.

1.5 QUALITY ASSURANCE

- A. Designer Qualifications: Design formwork under direct supervision of a Professional Structural Engineer experienced in design of concrete formwork and licensed in Texas.
- B. Maintain one copy of each installation standard on site throughout the duration of concrete work.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver prefabricated forms and installation instructions in manufacturer's packaging.
- B. Store prefabricated forms off ground in ventilated and protected manner to prevent deterioration from moisture.

PART 2 PRODUCTS

2.1 FORMWORK - GENERAL

- A. Provide concrete forms, accessories, shoring, and bracing as required to accomplish cast-in-place concrete work.
- B. Design and construct concrete that complies with design with respect to shape, lines, and dimensions.
- C. Comply with applicable state and local codes with respect to design, fabrication, erection, and removal of formwork.
- D. Comply with relevant portions of ACI CODE-318, ACI PRC-347, and ACI SPEC-301.

2.2 WOOD FORM MATERIALS

- A. Softwood Plywood: PS 1, B-B High Density Concrete Form Overlay, Class I.
- B. Lumber: Yellow Pine or equal species; no. 2 grade; with grade stamp clearly visible.

2.3 REMOVABLE PREFABRICATED FORMS

- A. Manufacturers:
 - 1. SureVoid Products, Inc: www.surevoid.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Preformed Steel Forms: Minimum 16 gauge, 0.0598 inch thick, matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.
 - 1. Exposed concrete finish areas shall use New or Like New Preformed Steel Forms.
- C. Pan Type: Steel, of size and profile indicated.
- D. Void Forms: Moisture resistant treated paper faces, biodegradable, structurally sufficient to support weight of wet concrete mix until initial set; 2 inches 2 inches thick.

2.4 FORMWORK ACCESSORIES

- A. Form Ties: Removable Removable type, galvanized metal galvanized metal, fixed fixed length, cone type, cone type, with waterproofing washer, with waterproofing washer, free of defects that could leave holes larger than 1 inch 1 inch in concrete surface.
- B. Form Release Agent: Capable of releasing forms from hardened concrete without staining or discoloring concrete or forming bugholes and other surface defects, compatible with concrete and form materials, and not requiring removal for satisfactory bonding of coatings to be applied.
 - 1. Do not use materials containing diesel oil or petroleum-based compounds.
 - 2. Products:
 - a. SpecChem, LLC; Bio Strip WB (water-based): www.specchemllc.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- C. Form Release Agent: Colorless mineral oil that will not stain concrete.
- D. Filler Strips for Chamfered Corners: Wood strip type; 3/4 x 3/4 inch size; maximum possible lengths.
- E. Dovetail Anchor Slot: Galvanized steel, at least 22 gauge, 0.0299 inch thick, foam filled, release tape sealed slots, anchors for securing to concrete formwork.
- F. Flashing Reglets: Galvanized steel, at least 22 gauge, 0.0299 inch thick, longest possible lengths, with alignment splines for joints, foam filled, release tape sealed slots, anchors for securing to concrete formwork.
- G. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.
- H. Embedded Anchor Shapes, Plates, Angles and Bars: As specified in Section 051200.
- I. Waterstops: PVC, complying with COE CRD-C 572.
 - 1. All horizontal and vertical construction joints shall contain a rubber water stop.
 - 2. Configuration: As indicated on drawings.
 - 3. Size: As indicated on drawings. If not shown use 4" minimum bulb tee type.
 - 4. Manufacturers:
 - a. BoMetals, Inc: www.bometals.com/#sle.
 - b. Greenstreak: www.usa.sika.com/en/construction/concrete/concrete-accessories/waterstop-systems/pvc-waterstop/greenstreak-pvc-waterstop.html.

- c. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

3.2 EARTH FORMS

- A. Hand trim sides and bottom of earth forms. Remove loose soil prior to placing concrete.

3.3 ERECTION - FORMWORK

- A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI SPEC-301.
- B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.
- C. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.
- D. Align joints and make watertight. Keep form joints to a minimum.
- E. Obtain approval before framing openings in structural members that are not indicated on drawings.
- F. Install void forms in accordance with manufacturer's recommendations. Protect forms from moisture or crushing.
- G. Coordinate this section with other sections of work that require attachment of components to formwork.
- H. If formwork is placed after reinforcement, resulting in insufficient concrete cover over reinforcement, request instructions from Architect/Structural Engineer of Record before proceeding.

3.4 APPLICATION - FORM RELEASE AGENT

- A. Apply form release agent on formwork in accordance with manufacturer's recommendations.
- B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.
- C. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings that are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.

3.5 REMOVAL OF FORMS

- A. Side forms of beams, walls and columns may be removed after cumulatively curing at not less than 50 degrees F (10 degrees C) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.
- B. Wall, beam, joist and slab soffits may be removed when all of the following conditions are satisfied:
1. Strength of concrete as shown by standard cylinder test has reached at least 2,500 psi and at least 75% of specified design strength.
 2. Concrete has cured at least 7 days (4 days for type 3 cement) or additional time as required if during cold weather.
 3. Soffit forms shall not be removed from members that are supporting any load such as construction materials or shoring for floor or roof above unless it can be determined that the member as sufficient strength to support such loading.

3.6 INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Provide formed openings where required for items to be embedded in passing through concrete work.
- B. Locate and set in place items that will be cast directly into concrete.
- C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other work.
- D. Position recessed anchor slots for brick veneer masonry anchors to spacing and intervals specified in Section 042613.

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- E. Install accessories in accordance with manufacturer's instructions, so they are straight, level, and plumb. Ensure items are not disturbed during concrete placement.
 - F. Install waterstops in accordance with manufacturer's instructions, so they are continuous without displacing reinforcement. Heat seal joints so they are watertight.
 - G. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.
 - H. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.
- 3.7 FORM CLEANING
- A. Clean forms as erection proceeds, to remove foreign matter within forms.
 - B. Clean formed cavities of debris prior to placing concrete.
 - 1. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.
 - 2. During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.
- 3.8 FORMWORK TOLERANCES
- A. Construct formwork to maintain tolerances required by ACI SPEC-117, unless otherwise indicated.
 - B. Construct and align formwork for elevator hoistway in accordance with ASME A17.1.
 - C. Camber slabs and beams 1/4 inch per 10 feet.
- 3.9 FORMWORK FINISH
- A. Construct formwork in accordance with ACI 347, unless otherwise indicated.
 - B. Refer to architectural drawings for exposure of formed surfaces.
 - 1. The following defines class of finish:
 - a. Class A - Surfaces prominently exposed to public view where appearance is of special importance, typically noted on architectural drawings as "exposed"
 - b. Class B - Coarse textured concrete formed surfaced intended to receive plaster, stucco or wainscoting.
 - c. Class C - General standard for permanently exposed surfaces where other finishes are not specified.
 - d. Class D - Minimal quality requirement for surfaces where roughness is not objectionable, usually applied where surface will be permanently concealed.
- 3.10 FIELD QUALITY CONTROL
- A. An independent testing agency will perform field quality control tests, as specified in Section 014000 - Quality Requirements.
 - B. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and to verify that supports, fastenings, wedges, ties, and items are secure.
 - C. Do not reuse wood formwork more than 2 times for concrete surfaces to be exposed to view. Do not patch formwork.
- 3.11 FORM REMOVAL
- A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.
 - B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
 - C. Store removed forms to prevent damage to form materials or to fresh concrete. Discard damaged forms.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 031000 - Concrete Forming and Accessories.
- B. Section 033000 - Cast-in-Place Concrete.
- C. Section 042000 - Unit Masonry: Reinforcement for masonry.

1.3 REFERENCE STANDARDS

- A. ACI CODE-318 - Building Code Requirements for Structural Concrete and Commentary; 2019 (Reapproved 2022).
- B. ACI MNL-66 - ACI Detailing Manual; 2020.
- C. ACI SPEC-301 - Specifications for Concrete Construction; 2020.
- D. ASTM A82/A82M - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement; 2007.
- E. ASTM A184/A184M - Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement; 2019.
- F. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.
- G. ASTM A996/A996M - Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement; 2016.
- H. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2022.
- I. AWS D1.4/D1.4M - Structural Welding Code - Steel Reinforcing Bars; 2018, with Amendment (2020).
- J. CRSI (DA4) - Manual of Standard Practice; 2009.
- K. CRSI (P1) - Placing Reinforcing Bars, 10th Edition; 2019.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Comply with requirements of ACI MNL-66 Include bar schedules, shapes of bent bars, spacing of bars, and location of splices.
- C. The Contractor shall obtain completely detailed shop drawings showing placement plans, bar bending lists, etc. Include the specific location and size of all accessories, chairs and bar supports. The Contractor shall carefully check these drawings, then submit them to the Architect/Engineer. The Architect/Engineer may conduct limited spot checks aimed solely at determining general comprehension of the design intent, then return them to the Contractor. The Contractor shall then carefully recheck the shop drawings and approve them prior to fabrication.
 - 1. NOTE: Regardless of the fabricators standard policy or other industry standards of practice, all straight and bent bars shall be tagged with the member mark. If the fabricator elects to use member marks other than those shown on the structural drawings, the members must also be labeled with the original engineer's member marks in addition to those of the fabricator.
- D. The Engineer's spot check shall not relieve the Contractor from correcting, at his own expense, any items that may thereafter be found not to comply with the plans and specifications.
- E. Manufacturer's Certificate: Certify that reinforcing steel and accessories supplied for this project meet or exceed specified requirements.
- F. Reports: Submit certified copies of mill test report of reinforcement materials analysis.

1.5 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI SPEC-301.

PART 2 PRODUCTS

2.1 REINFORCEMENT

- A. ALL REINFORCING (Unless noted otherwise)
 - 1. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi).
 - a. Plain billet-steel bars.
- B. BEAM STIRRUPS and COLUMN TIES
 - 1. Reinforcing Steel: Deformed bars, ASTM A996/A996M Grade 40 (280), Type A.
- C. Steel Welded Wire Reinforcement (WWR): Galvanized, deformed type; ASTM A1064/A1064M.
 - 1. Form: Flat Sheets.
 - 2. WWR Style: As indicated on drawings.
- D. Reinforcement Accessories:
 - 1. Tie Wire: Annealed, minimum 16 gauge, 0.0508 inch.
 - 2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.

2.2 RE-BAR SPLICING:

- A. Coupler Systems: Mechanical devices for splicing reinforcing bars.
 - 1. Comply with ACI CODE-318 steel reinforcing design strength requirements for splices in tension and compression.
 - 2. Products:
 - a. Dayton Superior Corporation: www.daytonsuperior.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- B. Dowel Bar Splicer with Dowel-Ins: Mechanical devices for splicing reinforcing bars.
 - 1. Comply with ACI CODE-318 steel reinforcing design strength requirements for splices in tension and compression.
 - 2. Products:
 - a. Dayton Superior Corporation: www.daytonsuperior.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

2.3 FABRICATION

- A. Fabricate concrete reinforcing in accordance with CRSI (DA4) - Manual of Standard Practice.
- B. Welding of reinforcement is not permitted.
- C. Locate reinforcing splices not indicated on drawings at point of minimum stress.
 - 1. Review locations of splices with Architect/Structural Engineer of Record .

PART 3 EXECUTION

3.1 PLACEMENT

- A. Place, support and secure reinforcement against displacement. Do not deviate from required position.
- B. Do not displace or damage vapor barrier.
- C. Accommodate placement of formed openings.

3.2 FABRICATION

- A. Reinforcing shall be fabricated in accordance with "Manual of Standard Building Code Requirements for Reinforced Concrete" (ACI 318), latest edition. The Contractor shall be responsible for obtaining properly fabricated reinforcing and placing it properly.
- B. Reinforcing steel, at the time concrete is placed, shall be free from excessive rust, scale, dried concrete, or other coatings that will destroy or reduce bond, in the opinion of the Engineer.
- C. Reinforcing steel shall be accurately shop bent and placed in position, securely tied or supported to prevent movement during placing of concrete. Field bends will not be permitted without prior approval from Engineer. Authorized field bends shall be performed cold; no heating is permitted. Spacer bars, supports and accessories are not scheduled but are to be furnished and placed as described under MATERIALS paragraph in this Section. Raising of reinforcement (including welded wire fabric) during the pour will not be permitted.

3.3 CONCRETE COVER

A. SUSPENDED STRUCTURES

1. Unless detailed otherwise on plans, reinforcing bars shall have concrete cover as follows:
 - a. Beam Stirrups; top, bottom and sides, 1-1/2".
 - b. Column ties and spirals, 1-1/2".
 - c. Concrete joists and slabs, 3/4".
 - d. Spread or spot footings, 3".

B. SLAB AND BEAMS ON FILL

1. Chair and/or block reinforcing securely in position with concrete cover as follows:
 - a. Beam stirrups; top, 1-1/2", bottom and sides 3".
 - b. Slab bars; 1-1/2" from top.
2. Support reinforcing steel on concrete blocks or bricks spaced at approximately 4'-0" o.c. in each direction.

3.4 SPLICES

- #### A. Necessary splices not shown on drawings or otherwise noted shall be in accordance with ACI specifications for bar sizes up to #11 size, but not less than 40 bar diameters. Splices in bars larger than #11 shall be made with approved thermal or mechanical coupling devices. Welding wire fabric shall be lapped 1-1/2 meshes, with a minimum lap of 8". All lap splices shall be contact type secured with annealed tie wire.

3.5 SLAB OPENINGS

- #### A. Unless shown otherwise, at slab openings of 12" or less, spread main reinforcing around opening. At slab openings greater than 12", provide 2 #4x4'-0" bottom placed diagonally at each corner. At sides of openings, provide one full bar for each bar cut at opening. No main bars shall be cut without Engineer's approval.

3.6 CONDUITS IN SLABS

- #### A. Electrical and mechanical conduit in slabs or joists shall run under upper layer of reinforcing or wire mesh; provide a minimum of 1-1/2" clear between conduits and between conduit and parallel reinforcing. Do not "bundle" conduits. See CONCRETE FORMWORK Section for thickened slab required at large conduits.

3.7 BEAM INTERSECTIONS

- #### A. Unless shown otherwise on plans, at corners, angle bends and at junction with other beams, provide four #7x6'-0" "corner bars" (3 ft. each leg) , 2 top and 2 bottom. For deep beams with scheduled intermediate bars, provide matching 80 diameter corner bars" of the same size. At "T" intersection, place all "corner bars" so that one leg is in outside face of outside beam.

3.8 WALL INTERSECTIONS

- #### A. Unless shown otherwise, at corners, angle bends, and at junction with other walls, lap all horizontal bars in both faces 30 diameters or use matching 80 diameter "Corner Bars".

3.9 BEAM TO WALL CONNECTION

- #### A. Unless shown otherwise, where beam abuts or frames into concrete wall, extend beam bars 30 diameters into wall, or use 60 diameter dowels or 60 diameter "corner bars" with 30 diameter embedment into both beam and wall; bar size and quantity shall match beam bars. See CONCRETE FORMWORK section for key seat at construction joint.

3.10 WALL ENDS

- #### A. Unless shown otherwise, where walls stop, position two (2) of the wall vertical bars at the end of the wall; provided that vertical bars are #6 or larger. If wall vertical bars are smaller than #6, use 2 #6 at wall ends in lieu of wall vertical bars. Provide #4 U-bars (30 diameter laps) enclosing vertical bars at end faces, same spacing as horizontal bars.

3.11 OPENINGS IN CONCRETE WALLS

- #### A. Unless shown otherwise, Add 2 #6 bars in each face over opening, extending 30 diameters beyond limits of opening, and add 2#5x5'-0" placed diagonally at each corner of opening. Provide #4 U-bars

(30 diameter laps) at end faces for each bar (horizontal or vertical) interrupted by opening. U-bars shall enclose horizontal or vertical bars at opening.

3.12 WALL DOWELS

- A. Unless shown otherwise, provide 60 diameter wall dowels from beam or footing to match the size and spacing of all vertical bars in wall above; extend 30 diameters into wall. At construction joints, either continue all vertical bars or provide for 30 diameter laps of all vertical bars into wall above.

3.13 COLUMN DOWELS

- A. Unless shown otherwise, provide dowels from bottom of beams, piers, footings or walls to match the size and quantity of bars scheduled in column above; extend 30 diameters into column. At construction joints, extend all vertical bars 30 diameters into column above; offset bars on 1 to 6 slope to provide proper lapping of bars in column above. If offset exceeds 3", stop lower column bars and provide separate 60 diameter dowels as described under "COLUMN DOWELS" above. Use contact lap splices as shown in details at column schedule.

3.14 COLUMN REINFORCEMENT

- A. Unless shown otherwise, provide scheduled ties along full length of vertical bars and dowels except that at soffit down into column below and above construction joints, start first tie at one half of scheduled tie spacing. Also, unless shown otherwise, include scheduled ties in areas of floor or roof framing members unless width of framing members exceeds width of column above by at least 2" on all four faces. Columns built into concrete walls shall be reinforced same as scheduled column. Two-piece ties shall be deformed bars only and minimum laps shall be 12" for No.3 bars; 15" for No. 4 bars. Terminate column vertical bars at an elevation of 3" below top of upper roof beam unless otherwise detailed; bars shall lap into upper roof beam at least 30 diameters; provide 90 degree bend at bar ends as required to accomplish this.

3.15 COLUMN PIER CAPS

- A. At columns carried directly by footing piers, and/or other places indicated on plans, construct a transitional pier cap extending from pier to column to allow accurate dowel or anchor bolt setting. Extend footing shaft reinforcing including hooping, to within 3" of top of plinth and make double wrap at top. Column dowels are as scheduled for column above. If column dowels occur outside of pier shaft hooping, provide "U" shaped ties (sizes, number, and spacing as scheduled for column above) for all such dowels.

3.16 TOPPING REINFORCEMENT

- A. Reinforcement (including welded wire fabric) shall be chaired to proper depth as shown on plans and sections. Raising of reinforcement during pour is not acceptable.
- B. CONSTRUCTION JOINTS
- C. Provide and locate as necessary in CAST-IN-PLACE CONCRETE Section.
- D. All reinforcing shall continue through the joint.
- E. Add extra reinforcing if so directed by Engineer.

3.17 FIELD QUALITY CONTROL

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

END OF SECTION

PART 1 GENERAL

0.1 SECTION INCLUDES

- A. Concrete building frame members.
- B. Concrete for composite floor construction.
- C. Elevated concrete slabs.
- D. Floors and slabs on grade.
- E. Concrete shear walls, elevator shaft walls, and foundation walls.
- F. Joint devices associated with concrete work.
- G. Miscellaneous concrete elements, including equipment pads, equipment pits, light pole bases, flagpole bases, thrust blocks, and manholes.
- H. Concrete curing.

0.2 RELATED REQUIREMENTS

- A. Section 031000 - Concrete Forming and Accessories: Forms and accessories for formwork.
- B. Section 032000 - Concrete Reinforcing.
- C. Section 033511 - Concrete Floor Finishes: Densifiers, hardeners, applied coatings, and polishing.
- D. Section 079200 - Joint Sealants: Products and installation for sealants and joint fillers for saw cut joints and isolation joints in slabs.

0.3 REFERENCE STANDARDS

- A. ASTM C595/C595M Standard Specification for Blended Hydraulic Cements - 2021 Edition, July 15, 2021
- B. ACI CODE-318 - Building Code Requirements for Structural Concrete and Commentary; 2019 (Reapproved 2022).
- C. ACI PRC-211.1 - Selecting Proportions for Normal-Density and High Density-Concrete - Guide; 2022.
- D. ACI PRC-302.1 - Guide to Concrete Floor and Slab Construction; 2015.
- E. ACI PRC-304 - Heavyweight Concrete: Measuring, Mixing, Transporting and Placing; 2020.
- F. ACI PRC-305 - Guide to Hot Weather Concreting; 2020.
- G. ACI PRC-306 - Guide to Cold Weather Concreting; 2016.
- H. ACI PRC-308 - Guide to External Curing of Concrete; 2016.
- I. ACI SPEC-301 - Specifications for Concrete Construction; 2020.
- J. ASTM A185/A185M - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete; 2007.
- K. ASTM A497/A497M - Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete; 2007.
- L. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2018.
- M. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2023.
- N. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2022a.
- O. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 50 mm [2 in.] Cube Specimens); 2023.
- P. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2020.
- Q. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.
- R. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete; 2020.
- S. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete; 2010a (Reapproved 2016).
- T. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2019.

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- U. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2019, with Editorial Revision (2022).
 - V. ASTM C618 - Standard Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2023.
 - W. ASTM C685/C685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing; 2017.
 - X. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 2020a.
 - Y. ASTM C1059/C1059M - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete; 2021.
 - Z. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2020.
 - AA. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete; 2018.
 - BB. ASTM D994/D994M - Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type); 2011 (Reapproved 2022).
 - CC. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types); 2018.
 - DD. ASTM D2103 - Standard Specification for Polyethylene Film and Sheeting; 2015.
 - EE. ASTM E1155 - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers; 2020.
 - FF. ASTM E1155M - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers (Metric); 2014.
 - GG. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs; 2017.
 - HH. COE CRD-C 513 - Handbook for Concrete and Cement Corps of Engineers Specifications for Rubber Waterstops; 1974.
 - II. COE CRD-C 572 - Handbook for Concrete and Cement Corps of Engineers Specifications for Polyvinylchloride Waterstop; 1974.
 - JJ. ICRI 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair; 2013.
 - NSF 61 - Drinking Water System Components - Health Effects; 2022, with Errata.
 - KK. NSF 372 - Drinking Water System Components - Lead Content; 2022.

0.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Mix Design: Submit mix design for each type of concrete proposed.
- C. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
 - 1. For curing compounds, provide data on method of removal in the event of incompatibility with floor covering adhesives.
- D. Mix Design: Submit proposed concrete mix design.
 - 1. Indicate proposed mix design complies with requirements of ACI SPEC-301, Section 4 - Concrete Mixtures.
 - 2. Indicate proposed mix design complies with requirements of ACI CODE-318, Chapter 5 - Concrete Quality, Mixing and Placing.
- E. Test Reports: Submit report for each test or series of tests specified.
- F. Sustainable Design Submittal: If any fly ash, ground granulated blast furnace slag, silica fume, rice hull ash, or other waste material is used in mix designs to replace Portland cement, submit the total volume of concrete cast in place, mix design(s) used showing the quantity of portland cement replaced, reports showing successful cylinder testing, and temperature on day of pour if cold weather mix is used.

0.5 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI SPEC-301 and ACI CODE-318.
- B. Follow recommendations of ACI PRC-305 when concreting during hot weather.
- C. Follow recommendations of ACI PRC-306 when concreting during cold weather.

0.6 MOCK-UPS

- A. Construct and erect mock-up panel for architectural concrete surfaces indicated to receive special treatment or finish as result of formwork.
 - 1. Panel Size: Sufficient to illustrate full range of treatment.
 - 2. Panel Size: 6 by 6 feet.
 - 3. Number of Panels: Two.
- B. If requested by Architect/Structural Engineer of Record , cast concrete against mock-up panel. Obtain acceptance of resulting surface finish prior to erecting formwork.

PART 2 PRODUCTS

1.1 FORMWORK

- A. Comply with requirements of Section 031000.

1.2 REINFORCEMENT MATERIALS

- A. Comply with requirements of Section 032000.

1.3 CONCRETE MATERIALS

- A. Cement: ASTM C150, Type I - Normal Portland type.
 - 1. Acquire cement for entire project from same source.
- B. Cement: ASTM C150, Type II - Moderate Portland type.
 - 1. Acquire cement for entire project from same source.
- C. Cement: ASTM C150, Type III - High Early Strength Portland type.
 - 1. Acquire cement for entire project from same source.
- D. Cement: ASTM C150, Type V - Sulfate Resistant Portland type.
 - 1. Acquire cement for entire project from same source.
- E. Blended Cement: ASTM C595, Type IL Portland type.
 - 1. Acquire cement for entire project from same source.
- F. Fine and Coarse Aggregates: ASTM C33/C33M.
 - 1. Acquire aggregates for entire project from same source.
- G. Fly Ash: ASTM C618, Class C or F.
 - 1. Fly Ash may not be combined in mix with Type IL Cement.
- H. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to concrete.

1.4 ADMIXTURES

- A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.
- B. High Range Water Reducing and Retarding Admixture: ASTM C494/C494M Type G.
- C. High Range Water Reducing Admixture: ASTM C494/C494M Type F.
- D. Water Reducing and Accelerating Admixture: ASTM C494/C494M Type E.
- E. Water Reducing and Retarding Admixture: ASTM C494/C494M Type D.
- F. Accelerating Admixture: ASTM C494/C494M Type C.
- G. Retarding Admixture: ASTM C494/C494M Type B.
- H. Water Reducing Admixture: ASTM C494/C494M Type A.
- I. Shrinkage Reducing Admixture:
 - 1. ASTM C494/C494M, Type S.
- J. Waterproofing Admixture: Admixture formulated to reduce permeability to liquid water, with no adverse effect on concrete properties.
 - 1. Potable Water Contact Approval: National Science Foundation (NSF) certification for use on structures holding potable water, based on testing in accordance with NSF 61 and NSF 372
 - 2. Products:

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- a. Aquafin, Inc: www.aquafin.net/#sle.
 - b. Xypex Chemical Corporation; XYPEX Admix C-500: www.xypex.com/#sle.
- 1.5 ACCESSORY MATERIALS
- A. Underslab Vapor Barrier (Slab on Grade):
 - 1. Materials
 - a. Sheet Retarder: Polyolefin film, 15 mil thick minimum; able to maintain water vapor permeance of 0.01 perms tested in accordance with mandatory conditioning tests per ASTM E1745, Section 7.1 (7.1.1-7.1.5) , tensile strength conforming with ASTM E1745 Class A and ACI 302.1R.
 - 2. MANUFACTURERS / PRODUCTS
 - a. Henry Company; Fortifiber Moistop Ultra: www.henry.com.
 - b. Reef Industries / Vaporguard; www.reefindustries.com
 - c. Stego Industries LLC / Stego Wrap Vapor Barrier; www.stegoindustries.com. (Basis of Design)
 - d. Reef Griffolyn "15 mil green" by Reef Industries
 - e. Substitutions: No substitutions.
 - B. Non-Shrink Cementitious Grout: Premixed compound consisting of nonmetallic aggregate, cement, water reducing and plasticizing agents.
 - 1. Minimum Compressive Strength at 48 Hours: 2,000 pounds per square inch.
 - 2. Minimum Compressive Strength at 28 Days: 7,000 pounds per square inch.
 - 3. Products containing aluminum powder are not permitted.
 - 4. Flowable Products:
 - a. Dayton Superior Corporation: www.daytonsuperior.com/#sle.
 - b. Euclid Chemical Company; NS GROUT: www.euclidchemical.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
 - 5. Low-Slump, Dry Pack Products:
 - a. Euclid Chemical Company; DRY PACK GROUT: www.euclidchemical.com/#sle.
 - b. Dayton Superior Corporation: www.daytonsuperior.com/#sle.
 - c. W. R. Meadows, Inc; PAC-IT: www.wrmeadows.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- 1.6 BONDING AND JOINTING PRODUCTS
- A. Latex Bonding Agent: Non-redispersable acrylic latex, complying with ASTM C1059/C1059M, Type II.
 - 1. Products:
 - a. Euclid Chemical Company; AKKRO-7T: www.euclidchemical.com/#sle.
 - b. SpecChem, LLC; Strong Bond Acrylic Bonder: www.specchemllc.com/#sle.
 - c. W. R. Meadows, Inc; ACRY-LOK-: www.wrmeadows.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
 - B. Epoxy Bonding System:
 - 1. Complying with ASTM C881/C881M and of Type required for specific application.
 - 2. Products:
 - a. Euclid Chemical Company; DURAL FAST SET LV: www.euclidchemical.com/#sle.
 - b. Dayton Superior Corporation: www.daytonsuperior.com/#sle.
 - c. SpecChem, LLC; SpecPoxy 1000, SpecPoxy 2000, SpecPoxy 3000, or SpecPoxy 3000FS: www.specchemllc.com/#sle.
 - d. W. R. Meadows, Inc; Rezi-Weld Gel Paste, Rezi-Weld Gel Paste State, Rezi-Weld 1000: www.wrmeadows.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
 - C. Waterproofing Admixture Slurry: Slurry coat of Portland cement, sand, and crystalline waterproofing additive, mixed with water in proportions recommended by manufacturer to achieve waterproofing at cold joints in concrete.
 - 1. Products:
 - a. Aquafin, Inc: www.aquafin.net/#sle.
 - b. W. R. Meadows, Inc; ADI-CON CW Plus: www.wrmeadows.com/#sle.

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- c. Xypex Chemical Corporation; XYPEX Concentrate: www.xypex.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
 - D. Waterstops: Rubber, complying with COE CRD-C 513.
 - 1. **All construction joints, pour breaks, etc. with soil on one side or other shall have a waterstop. All waterstops are not shown on drawings.**
 - a. Configuration: Ribbed with centerbulb
 - b. Size: 6".
 - c. Products:
 - 1) Greenstreak Model 705.
 - 2) Greenstreak Model 724 (for form saver).
 - 3) Greestreak Model 698 (for base seal)
 - 4) Greenstreak Model 667 (for retrofit systems)
 - d. Substitutions: See Section 016000 - Product Requirements.
 - E. Reglets: Formed steel sheet, galvanized, with temporary filler to prevent concrete intrusion during placement.
 - 1. Size: As indicated on drawings.
 - F. Joint Filler: Nonextruding, resilient asphalt impregnated fiberboard or felt, complying with ASTM D 1751, 1/4 inch thick and 4 inches deep ; tongue and groove profile.
 - G. Joint Filler: Compressible asphalt mastic with felt facers, complying with ASTM D 994, thickness as indicated on drawings and full depth of slab less 1/2 inch.
 - H. Slab Construction Joint Devices: Combination keyed joint form and screed, galvanized steel, with rectangular or round knockout holes for conduit or rebar to pass through joint form at 6 inches on center; ribbed steel stakes for setting.
 - 1.7 CURING MATERIALS
 - A. Evaporation Reducer: Liquid thin-film-forming compound that reduces rapid moisture loss caused by high temperature, low humidity, and high winds; intended for application immediately after concrete placement.
 - 1. Products:
 - a. Dayton Superior Corporation: www.daytonsuperior.com/#sle.
 - b. Euclid Chemical Company ; www.euclidchemical.com/#sle.
 - c. SpecChem, LLC; SpecFilm Concentrate or SpecFilm: www.specchemllc.com/#sle.
 - d. W. R. Meadows, Inc ; Evapre or Evapre-RTU: www.wrmeadows.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
 - B. Curing Compound, Naturally Dissipating: Clear, water-based, liquid membrane-forming compound; complying with ASTM C309.
 - 1. Product dissipates within 4 to 6 weeks.
 - 2. Products:
 - a. Dayton Superior Corporation: www.daytonsuperior.com.
 - b. Euclid Chemical Company; www.euclidchemical.com.
 - c. SpecChem, LLC; SpecRez: www.specchemllc.com.
 - d. W. R. Meadows, Inc; 1100-Clear: www.wrmeadows.com.
 - e. Substitutions: See Section 016000 - Product Requirements.
 - C. Curing Compound, Non-Dissipating: Liquid, membrane-forming, clear, nonyellowing acrylic; complying with ASTM C309.
 - 1. Vehicle: Water-based.
 - 2. Gloss: Low.
 - 3. Solids by Mass: 15 percent, minimum.
 - 4. VOC Content: OTC compliant.
 - 5. Products:
 - a. Dayton Superior Corporation: www.daytonsuperior.com/#sle.
 - b. L&M Construction Chemicals, Inc, a subsidiary of Laticrete International, Inc; Dress & Seal WB: www.lmcc.com/#sle.

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- D. Moisture-Retaining Sheet: ASTM C171.
 - 1. Curing paper, regular.
 - 2. Polyethylene film, white opaque, minimum nominal thickness of 4 mil, 0.004 inch.
 - 3. White-burlap-polyethylene sheet, weighing not less than 3.8 ounces per square yard.
 - E. Polyethylene Film: ASTM D2103, 4 mil, 0.004 inch thick, clear.
 - F. Water: Potable, not detrimental to concrete.
- 1.8 CONCRETE MIX DESIGN
- A. Proportioning Normal Weight Concrete: Comply with ACI PRC-211.1 recommendations.
 - B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI SPEC-301.
 - 1. For trial mixtures method, employ independent testing agency acceptable to Architect/Structural Engineer of Record for preparing and reporting proposed mix designs.
 - C. Admixtures: Add acceptable admixtures as recommended in ACI PRC-211.1 and at rates recommended or required by manufacturer.
 - D. Normal Weight Concrete:
 - 1. Compressive Strength, when tested in accordance with ASTM C 39/C 39M at 28 days: 3000 psi.
 - a. Fly Ash Content: Maximum 20 percent of cementitious materials by weight.
 - 1) Fly Ash is not allowed in Type IL Cement mix designs.
 - b. Cement Content: Minimum 470 lb per cubic yard.
 - c. Maximum Slump: 5 inches. \pm 1/2"
 - 1) Slump shall be increased to 8 inches for drilled footings by means of chemical admixtures.
 - d. Maximum Aggregate Size:
 - 1) SLAB AND BEAMS ON FILL
 - (a) Unless detailed otherwise on plans maximum aggregate size shall be as follows:
 - (1) Beams and slabs, 1".
 - 2. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: 4,000 psi.
 - a. Fly Ash Content: Maximum 20 percent of cementitious materials by weight.
 - 1) Fly Ash is not allowed in Type IL Cement mix designs.
 - b. Cement Content: Minimum 517 pounds per cubic yard.
 - c. Water-Cement Ratio: Maximum 40 percent by weight.
 - d. Maximum Slump: 5 inches. \pm 1/2"
 - 1) Slump shall be increased to 8 inches for drilled footings by means of chemical admixtures.
 - e. Maximum Aggregate Size:
 - 1) SUSPENDED STRUCTURES
 - (a) Unless detailed otherwise on plans maximum aggregate size shall be as follows:
 - (1) Beams and slabs, 3/4".
 - (2) Columns and walls, 3/4".
 - (3) Concrete joists and slabs, 3/4".
 - (4) Spread or spot footings, 1-1/2".
 - (5) Drilled Piers, 1-1/2".
 - 3. Compressive Strength, when tested in accordance with ASTM C 39/C 39M at 28 days: 5000 psi.
 - a. Fly Ash Content: Maximum 20 percent of cementitious materials by weight.
 - 1) Fly Ash is not allowed in Type IL Cement mix designs.
 - b. Cement Content: Minimum 564 lb per cubic yard.
 - c. Maximum Slump: 5 inches. \pm 1/2"
 - 1) Slump shall be increased to 8 inches for drilled footings by means of chemical admixtures.
 - d. Maximum Aggregate Size:
 - 1) SUSPENDED STRUCTURES

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- (a) Unless detailed otherwise on plans maximum aggregate size shall be as follows:
 - (1) Beams and slabs, 3/4".
 - (2) Columns, 3/4".
 - (3) Concrete joists and slabs, 3/4".
 - (4) Spread or spot footings, 1-1/2".
 - (5) Drilled Piers, 1-1/2".
 - 2) SLAB AND BEAMS ON FILL
 - (a) Unless detailed otherwise on plans maximum aggregate size shall be as follows:
 - (1) Beams and slabs, 1".
 - (2) Tilt-Wall Panels, 3/4".
 - E. Control Low Strength Material (Flowable Fill):
 - 1. Compressive Strength, when tested in accordance with ASTM C 39/C 39M at 28 days: 50 to 100 psi.
 - 2. Cement Content: Minimum 100 lb per cubic yard.
 - 3. Fly Ash Content: Minimum 300 lb per cubic yard.
 - 4. Sand Content: Minimum 2,600 lb per cubic yard.
 - 5. Added Water Minimum 500 lb per cubic yard.
- 1.9 MIXING
- A. On Project Site: Mix in drum type batch mixer, complying with ASTM C685/C685M. Mix each batch not less than 1-1/2 minutes and not more than 5 minutes.
 - B. Transit Mixers: Comply with ASTM C94/C94M.
 - C. Adding Water: If concrete arrives on-site with slump less than suitable for placement, do not add water that exceeds the maximum water-cement ratio or exceeds the maximum permissible slump.

PART 3 EXECUTION

2.1 EXAMINATION

- A. Verify lines, levels, and dimensions before proceeding with work of this section.
- B. Verify condition of substrate and adjacent materials under provisions of Section 01 40 00 - Quality Requirements.

2.2 CONSTRUCTION JOINTS

- A. Provide in monolithic concrete framing so that not more than 400 cubic yards is placed in one day and no side dimension of the section being concreted is greater than 150 feet. Larger areas shall be approved by the Engineer.
- B. Locate so as not to impair the strength of the structure, and coordinate the location and details with the Architect/Engineer. Location shall generally be near the middle of the spans of slabs and beams with wood or steel-formed soffits. When soffits are formed with cardboard cartons, locate construction joint on centerline of pier.
- C. Provisions shall be made for transfer of shear and other forces through the joint. Generally this shall consist of forming horizontal keyways at mid-depth, 1-1/2" deep X 1/3 of beam or slab depth and allowing all reinforcing to continue through the joint. Add extra reinforcing if so directed by Engineer.
- D. Follow procedure for "Bonding new concrete to old", as described herein.
- E. Provide waterstops at all construction joints with soil or water on one side or other.

2.3 PREPARATION

- A. Formwork: Comply with requirements of ACI SPEC-301. Design and fabricate forms to support all applied loads until concrete is cured and for easy removal without damage to concrete.
- B. Verify that forms are clean and free of rust before applying release agent.
- C. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.
- D. Prepare existing concrete surfaces to be repaired according to ICRI 310.2R.

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- E. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning and applying bonding agent in accordance with bonding agent manufacturer's instructions.
 - 1. Use epoxy bonding system for bonding to damp surfaces, for structural load-bearing applications, and where curing under humid conditions is required.
 - 2. Use latex bonding agent only for non-load-bearing applications.
 - F. Where new concrete with integral waterproofing is to be bonded to previously placed concrete, prepare surfaces to be treated in accordance with waterproofing manufacturer's instructions. Saturate cold joint surface with clean water, and remove excess water before application of coat of waterproofing admixture slurry. Apply slurry coat uniformly with semi-stiff bristle brush at rate recommended by waterproofing manufacturer.
 - G. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.
- 2.4 INSTALLING VAPOR RETARDER
- A. Install materials in accordance with manufacturer's instructions and ASTM E1643.
 - B. Install vapor retarder with long dimension in direction of pour.
 - C. Extend vapor retarder to the perimeter of the slab. If practicable, terminate it at approximately the level of finish grade or slightly below, otherwise (a) at a point acceptable to the structural engineer or (b) where obstructed by impediments, such as dowels, waterstops, or any other site conditions requiring early termination of the vapor retarder. At the point of termination, seal vapor retarder to the slab itself using Stego Crete Claw tape, per manufacturer's instructions.
 - D. Overlap vapor retarder 6 inches where jointing is required. Seal with manufacturer's tape.
 - E. Seal all penetrations (including pipes) per manufacturer's instructions.
 - F. Penetrations through the vapor barrier are prohibited except reinforcing steel and permanent
 - G. Repair damaged areas in accordance with manufacturer's requirements.
 - H. Contact the manufacturer's representative to coordinate a review of the vapor retarder installation either by digital review or in person.
- 2.5 INSTALLING REINFORCEMENT AND OTHER EMBEDDED ITEMS
- A. Comply with requirements of ACI SPEC-301. Clean reinforcement of loose rust and mill scale, and accurately position, support, and secure in place to achieve not less than minimum concrete coverage required for protection.
 - B. Install welded wire reinforcement in maximum possible lengths, and offset end laps in both directions. Splice laps with tie wire.
 - C. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with concrete placement.
 - D. Provide waterstop material at all joints below grade.
- 2.6 PLACING CONCRETE
- A. Place concrete in accordance with ACI PRC-304.
 - B. Place concrete for floor slabs in accordance with ACI PRC-302.1.
 - C. Notify Architect/Structural Engineer of Record not less than 24 hours prior to commencement of placement operations.
 - D. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.
 - E. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.
 - F. Carbon Monoxide and Carbon Dioxide Exposure: General Contractor shall be responsible for monitoring interior concrete floor exposure to excessive exhaust gases containing carbon dioxide (CO₂) or carbon monoxide (CO) during delivery, placement and finishing of concrete and until concrete floor is protected by specified curing method.
 - 1. CO₂ levels shall not exceed 4,500 parts per million. CO levels shall not exceed 15 parts per million at concrete surface within 5 feet of any source of exhaust gases.
 - a. Levels shall be monitored utilizing appropriate meter from company similar to CEA Instruments, Inc., 16 Chestnut Street, Emerson, NJ 07630; Phone (201-967-5660);

2. Unvented combustion heaters shall not be in operation during concrete placement.
3. Limit combustion engine equipment inside building during concrete to only that equipment necessary to place and finish concrete.
4. Only two concrete trucks shall be in building at any given time and under no circumstance shall there be any earth moving equipment, dump trucks, grading equipment, or any other motorized equipment in operation until after the interior concrete floor is placed and protected by specified curing method.

2.7 SLAB JOINTING

- A. Locate joints as indicated on drawings or as submitted and approved by Architect/Engineer.
- B. Provide waterstop material per paragraph above at all joints below grade and joints shown to have waterstop.
- C. Anchor joint fillers and devices to prevent movement during concrete placement.
- D. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.
- E. Load Transfer Construction and Contraction Joints: Install load transfer devices as indicated; saw cut joint at surface as indicated for contraction joints.
- F. Saw Cut Contraction Joints: Saw cut joints before concrete begins to cool, within 4 to 12 hours after placing; use 3/16 inch thick blade and cut at least 1 inch deep but not less than one quarter (1/4) the depth of the slab.
- G. Construction Joints: Where not otherwise indicated, use metal combination screed and key form, with removable top section for joint sealant.
- H. Repair underslab vapor retarder damaged during placement of concrete reinforcing. Repair with vapor retarder material; lap over damaged areas minimum 6 inches and seal watertight.
- I. Separate slabs on grade from vertical surfaces with joint filler.
- J. Place joint filler in floor slab pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.
- K. Extend joint filler from bottom of slab to within 1/2 inch of finished slab surface. Conform to Section 079005 for finish joint sealer requirements.
- L. Install joint devices in accordance with manufacturer's instructions.
- M. Install construction joint devices in coordination with floor slab pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.
- N. Apply sealants in joint devices in accordance with Section 079005.
- O. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- P. Place concrete continuously between predetermined expansion, control, and construction joints.
- Q. Do not interrupt successive placement; do not permit cold joints to occur.

2.8 FLOOR FLATNESS AND LEVELNESS

- A. Flatness and levelness tolerances for floors shall conform to the requirements set forth in ACI 117, "Standard Tolerances for Concrete Construction and Materials", particularly section 4.5.6 and 4.5.7. Either of the following specifications is acceptable.
 1. Face Floor Profile Numbers (F-Numbers):
 - a. CONVENTIONAL, BULL-FLOATED; Flatness Ff = 15 Level Fl = 13
 - b. CONVENTIONAL STRAIGHTEDGED; Flatness Ff = 20 Level Fl = 15
 - c. FLAT; Flatness Ff = 30 Level Fl = 20
 - d. VERY FLAT; Flatness Ff = 50 Level Fl = 30
 2. 10-ft. Straightedge Method:
 - a. CONVENTIONAL, BULL-FLOATED; 1/2 in.
 - b. CONVENTIONAL, STRAIGHTEDGED; 5/16 in.
 - c. FLAT; 3/16 in.
 - d. VERY FLAT; 1/8 in.
- B. Unless noted otherwise, slab surfaces shall conform to the following criteria:
 1. Offices, classrooms, corridors, etc: FLAT.

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2. Slabs (permanent or temporary) to be used as casting beds for job cast tilt walls. VERY FLAT
 3. Warehouses, storerooms, equipment rooms: STRAIGHTEDGED.
 4. Sidewalks, plazas, pavement: BULL-FLOATED.
 5. Gymnasium Floors: VERY FLAT
- C. Measure F(F) Floor Flatness and F(L) Floor Levelness in accordance with ASTM E1155 (ASTM E1155M), within 48 hours after slab installation; report both composite overall values and local values for each measured section.
- D. Correct the slab surface if composite overall value is less than specified and if local value is less than two-thirds of specified value or less than F(F) 13/F(L) 10.
- 2.9 SEPARATE FLOOR TOPPINGS
- A. Prior to placing floor topping, roughen substrate concrete surface and remove deleterious material. Broom and vacuum clean.
 - B. Place required dividers, edge strips, reinforcing, and other items to be cast in.
 - C. Apply bonding agent to substrate in accordance with manufacturer's instructions.
 - D. Place concrete floor toppings to required lines and levels.
 1. Place topping in checkerboard panels not to exceed 20 feet in either direction.
- 2.10 CONCRETE FINISHING
- A. Repair surface defects, including tie holes, immediately after removing formwork.
 - B. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch or more in height.
 - C. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/4 inch or more in height. Provide finish as follows:
 1. Smooth Rubbed Finish: Wet concrete and rub with carborundum brick or other abrasive, not more than 24 hours after form removal.
 - D. Concrete Slabs: Finish to requirements of ACI PRC-302.1 and as follows:
 1. Surfaces to Receive Thick Floor Coverings: "Wood float" as described in ACI PRC-302.1; thick floor coverings include quarry tile, ceramic tile, and Portland cement terrazzo with full bed setting system.
 2. Surfaces to Receive Thin Floor Coverings: "Steel trowel" as described in ACI PRC-302.1; thin floor coverings include carpeting, resilient flooring, seamless flooring, resinous matrix terrazzo, thin set quarry tile, and thin set ceramic tile.
 3. Other Surfaces to Be Left Exposed: Trowel as described in ACI PRC-302.1, minimizing burnish marks and other appearance defects.
 - a. Chemical Hardener: See Section 033511.
 - E. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains at 1:100 nominal.
- 2.11 CURING AND PROTECTION
- A. Comply with requirements of ACI PRC-308. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
 - B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
 1. Normal concrete: Not less than seven days.
 2. High early strength concrete: Not less than four days.
 - C. Formed Surfaces: Cure by moist curing with forms in place for full curing period.
 - D. Surfaces Not in Contact with Forms:
 1. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.
 - a. Spraying: Spray water over floor slab areas and maintain wet.
or
 - b. Saturated Burlap: Saturate burlap-polyethylene and place burlap-side down over floor slab areas, lapping ends and sides; maintain in place.
 2. Final Curing: Begin after initial curing but before surface is dry.
 - a. Moisture-Retaining Sheet: Lap strips not less than 3 inches and seal with waterproof tape or adhesive; secure at edges.

or

- b. Curing Compound: Apply in two coats at right angles, using application rate recommended by manufacturer.

2.12 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 014000 - Quality Requirements.
- B. Provide free access to concrete operations at project site and cooperate with appointed firm.
- C. Concrete testing shall be at point of discharge. If concrete is pumped concrete shall be tested at the end of the discharge hose. If deposited directly from truck test may be made at truck.
- D. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
- E. Compressive Strength Tests: ASTM C 39/C 39M. For each test, mold and cure four concrete test cylinders. Obtain test samples for every 80 cu yd or less of each class of concrete placed each day with a minimum of 50 cu yd between each test.
- F. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
- G. Perform one slump test for each set of test cylinders taken, following procedures of ASTM C143/C143M. Slump test shall be at point of discharge.

2.13 DEFECTIVE CONCRETE

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

2.14 PROTECTION

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

2.15 BELOW STRENGTH CONCRETE

- A. If the 28-day cylinder strengths fall below the specified strength, the concrete represented by such test cylinders shall be considered unacceptable and subject to removal. Consideration will be given to the acceptance of such concrete if it can be demonstrated to the satisfaction of the Engineer that the cylinder tests do not accurately represent the strength of the concrete in place, or that the structure is fully capable of carrying the loads for which it was designed. This data may be obtained by a series of non-destructive tests and core tests in accordance with ASTM C-42 of the concrete in place, and/or by load testing in accordance with applicable codes. All costs in connection with this additional testing and/or removal and replacement of defective concrete shall be paid by the Contractor.

END OF SECTION

SECTION 033543 - POLISHED CONCRETE FINISHING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Polished concrete finish.
- B. Related Sections:
 - 1. Division 01: Administrative, procedural, and temporary work requirements.
 - 2. Structural Drawings and Specifications.

1.2 SUBMITTALS

- A. Submittals for Review:
 - 1. Product Data: Manufacturer's descriptive data and application instructions for concrete treatment products.
- B. Quality Control Submittals:
 - 1. Applicator qualifications, including list of previous projects and certification issued by flooring system manufacturer.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Minimum 2 years documented experience in work of this Section.
 - 2. Certified by concrete treatment manufacturer.
 - 3. Certified by Concrete Polishing Council of ASCC.
- B. Concrete:
 - 1. Mix Design: Free from admixtures and additives not specifically approved by concrete surface treatment manufacturer.
 - 2. Curing compound acceptable to concrete treatment manufacturer.
- C. Mockup:
 - 1. Provide requirements for a standalone, minimum, 100 square-foot mockup for approval by the design team and Owner.
 - 2. Review level of finishing and sheen with the Owner at the campus for approval.
 - 3. Provide requirements for staging and sequencing of concrete finishing of slabs at edges of spaces so uniformity of finishing is consistent with overall finishing.
 - 4. Locate where directed.
 - 5. Approved mockup may not remain as part of the Work.

- D. Pre-Installation Conference:
 - 1. Convene 2 weeks prior to beginning work of this section.
 - 2. Attendance: Owner, Architect, Contractor, and Subcontractor.
 - 3. Review and discuss:
 - a. Staging and sequencing.
 - b. Protection of completed work.
- E. Coefficient of Friction: Minimum 0.43, tested to ANSI/NFSI B101.3 after polishing.

1.4 PROJECT CONDITIONS

- A. Protect concrete surfaces scheduled to receive polished finish prior to finishing; prevent damage and staining:
 - 1. Prohibit pipe cutting operations on surfaces to be polished.
 - 2. Prohibit storage on surfaces to be polished for minimum 28 days after concrete placement.
 - 3. Prohibit ferrous metals storage on surfaces to be polished.
 - 4. Prevent liquid drippings from equipment on surfaces to be polished.
 - 5. Prevent acids and acidic detergents from contacting surfaces to be polished.
 - 6. Prevent painting over surfaces to be polished.
- B. Apply concrete treatment when ambient and surface temperatures are between 35 and 90 degrees F.
- C. Close areas to traffic during finishing and for minimum time period after finishing as recommended by concrete treatment manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Advanced Floor Products. (www.retroplatesystem.com)
 - 2. Ameripolish. (www.ameripolish.com)
 - 3. Sika. (www.sika.com)
 - 4. Floor Seal Technology, Inc. (www.floorseal.com)
- B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. CONC-1 – Polished Concrete Finish: Polished concrete floor with charcoal integral color. Meet ADA compliance for slip resistance, sealed with non-slip finish.
- B. Concrete Materials: Refer to Structural Drawings and Specifications.

1. Integral Color: Charcoal color to be selected by samples.
- C. Densifier: Odorless, non-hazardous, silicate that penetrates concrete to react with free lime and calcium hydroxide to produce permanent chemical reaction that hardens and densifies concrete surface.
 - D. Sealer: Non-film forming, stain resistant, food resistant, chemical stain resistant, impregnating sealant designed for use on concrete surfaces previously densified.
- 2.3 ACCESSORIES
- A. Cleaning Products: Non-corrosive, neutral pH, of type recommended by concrete treatment manufacturer.
 - B. Patching Compound: 40 percent Portland cement, 45 percent limestone, and 15 percent vinyl acetate copolymer, mixed with dust salvaged from grinding process to form paste.
 - C. Grout: Clear modified silicate sealant, free from latexes, mixed with dust salvaged from grinding process to form paste that reacts with calcium hydroxide in concrete.
- 2.4 EQUIPMENT
- A. Field Grinding and Polishing Equipment:
 1. Variable speed, multiple head, counter-rotating, walk-behind machine with minimum 600 pounds of down pressure on grinding or diamond polishing pads.
 2. If dry grinding, honing, or polishing, use dust extraction equipment with flow rate suitable for dust generated, with squeegee attachments.
 - B. Edge Grinding and Polishing Equipment: Hand-held or walk-behind machines producing same results as field grinding and polishing equipment without noticeable differences.
 - C. Burnishing Equipment: High speed walk-behind or ride-on machines capable of generating 1000 to 2000 revolutions per minute and with minimum head pressure of 20 pounds.
 - D. Metal Bonded Pads: Grinding pads with embedded industrial grade diamonds of varying grits.
 - E. Resin Bonded Pads: Polishing pads with embedded industrial grade diamonds of varying grits.
 - F. Burnishing Pads: Maintenance pads for use with high speed burnishing equipment.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Testing Concrete Floors:
 1. Alkalinity:
 - a. Test method: Measure pH according to ASTM F710.

- b. Acceptable results: pH between 8 and 10.
2. Moisture Vapor Transmission:
 - a. Test method: Perform anhydrous calcium chloride test to ASTM F1869.
 - b. Acceptable results: Maximum 5 pounds per 1000 square feet in 24 hours.
3. Relative humidity:
 - a. Test method: Perform relative humidity test using in situ probes to ASTM F2170.
 - b. Acceptable results: Maximum 75 percent.

3.2 POLISHING

- A. Initial Grinding:
 1. Use grinding equipment with metal bonded grinding pads.
 2. Begin grinding in one direction using sufficient size grit pad.
 3. Make sequential passes with each pass perpendicular to previous pass using finer grit pad with each pass, up to 150 grit.
 4. Achieve maximum refinement with each pass before proceeding to finer grit pads.
 5. Vacuum floor using squeegee vacuum attachment after each pass.
 6. Continue grinding until aggregate exposure matches approved mockup.
- B. Treating Surface Imperfections:
 1. Mix patching compound and grout material with dust created by grinding operations to match color of adjacent concrete surface.
 2. Fill surface imperfections. Work compound and treatment until color differences between concrete surface and filled surface imperfections are not noticeable when viewed from 10 feet away under lighting conditions that will be present after construction.
 3. Honing:
 - a. Use grinding equipment with resin bonded grinding pads.
 - b. Grind concrete in one direction starting with 50 grit pad; make as many sequential passes as required to remove scratches, each pass perpendicular to previous pass, up to 200 grit pad reaching maximum refinement with each pass before proceeding to finer grit pads.
 - c. Auto scrub or vacuum floor using squeegee vacuum attachment after each pass.
- C. Liquid Densifier Application: Apply undiluted solution to point of rejection, remove excess liquid, and allow to cure according to manufacturers instructions.
- D. Grout Grinding:
 1. Use grinding equipment and appropriate grit grinding pads.
 2. While applying fresh grout material prior to surface, grind concrete in direction perpendicular to initial grinding to remove scratches.
 3. Vacuum floor using squeegee vacuum attachment after each pass.
- E. Honing:

1. Use grinding equipment with resin bonded grinding pads.
 2. Grind concrete in one direction starting with 50 grit pad; make as many sequential passes as required to remove scratches, each pass perpendicular to previous pass, up to 400 grit pad reaching maximum refinement with each pass before proceeding to finer grit pads.
 3. Auto scrub or vacuum floor using squeegee vacuum attachment after each pass.
- F. Polishing:
1. Use polishing equipment with resin bonded polishing and burnishing pads.
 2. Begin polishing in one direction starting with 800 grit pad.
 3. Make sequential passes with each pass perpendicular to previous pass using finer grit pad with each pass.
 4. Achieve maximum refinement with each pass before proceeding to finer grit pads.
 5. Auto scrub or vacuum floor using squeegee vacuum attachment after each pass.
 6. Continue polishing until gloss appearance, as measured according to ASTM E430, matches approved mockup.
- G. Final Polished Concrete Floor Finish: Class B - Fine Aggregate Finish: Remove maximum 1/16 inch of concrete surface by grinding and polishing resulting in majority of exposure displaying 85 – 95% Fine Aggregate and 5 – 15% Blend of Cement Fines and Coarse Aggregate; salt and pepper finish.
- H. Final Concrete Floor Gloss: Level 2 - Satin (Honed) Gloss Appearance:
1. Procedure: Minimum five step process with full refinement of each diamond pad up to 400 grit resin bonded pad with one application of densifier.
 2. Gloss reading: Distinctness-of-Image (DOI) Gloss Image Clarity Value 10 – 39 percent tested to ASTM D5767 and Haze Index less than 10 tested to ASTM D4039.

3.3 SEALING

- A. Apply sealer to manufacturer's recommend coverage.
- B. Remove excessive sealer.
- C. Using burnishing equipment and finest grit burnishing pads, burnish to uniform sheen matching approved mockup.

3.4 FIELD QUALITY CONTROL

- A. Measure slip resistance using BOT-3000 slip-tester; ensure compliance with specified slip resistance rating.

3.5 PROTECTION

- A. Close areas to traffic until concrete treatment has cured.
- B. Protect completed work with nonstaining sheet coverings.

END OF SECTION

DIVISION 04

Masonry

95% Construction Documents

SECTION 04 03 10 – HISTORIC STONE MASONRY CLEANING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes historic treatment work consisting of cleaning exposed historic stone masonry surfaces.
- B. Related Requirements:
1. Section 01 35 91 "Historic Treatment Procedures" for general historic treatment requirements.
 2. Section 04 03 42 "Historic Stone Masonry Repair and Repointing" for stone masonry repair treatment requirements.

1.3 UNIT PRICES

- A. Work of this Section is affected by unit prices specified in Section 012200 "Unit Prices."

1.4 DEFINITIONS

- A. Very Low-Pressure Spray: Less than 100 psi (690 kPa);
- B. Low-Pressure Spray: 100 to 400 psi (690 to 2750 kPa);
- C. Medium-Pressure Spray: 400 to 800 psi (2750 to 5510 kPa);
- D. High-Pressure Spray: 800 to 1200 psi (5510 to 8250 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference on historic masonry cleaning at General Contractor's field office adjacent to project site.
1. Review minutes of Preliminary Historic Treatment Conference that pertain to masonry historic treatment and cleaning.
 2. Review methods and procedures related to cleaning historic masonry, including, but not limited to, the following:
 - a. Historic treatment specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, material application, and sequencing.
 - c. Quality-control program.
 - d. Fire-protection plan.
 - e. Cleaning program.
 - f. Coordination with building occupants or City personnel.

1.6 SEQUENCING AND SCHEDULING

- A. Work Sequence: Perform historic masonry cleaning work in the following sequence, using the gentlest methods possible first:
1. Remove plant growth.
 2. Inspect masonry for open mortar joints. Where repairs are required, delay further cleaning work until after repairs are completed, cured, and dried to prevent the intrusion of water and other cleaning materials into the wall.
 3. Remove paint.
 4. Clean masonry.

- B. Scaffolding, if required, shall be self-supporting and not anchored to historic materials or features. Coordinate scaffolding with other rehabilitation work.

1.7 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include material descriptions and application instructions.
 - 2. Include test data substantiating that products comply with requirements.

1.8 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For historic treatment specialists including field supervisors and workers, paint-remover manufacturer, and chemical-cleaner manufacturer.
- B. Preconstruction Test Reports: For cleaning materials and methods.
- C. Quality-control program.
- D. Cleaning program.

1.9 QUALITY ASSURANCE

- A. Basis for Standard of Care: U.S. Department of the Interior – National Park Service – Standards and Guidelines.
- B. Historic Treatment Specialist Qualifications: A qualified historic masonry cleaning specialist. Experience cleaning new masonry work is insufficient experience for historic treatment work.
- C. Paint-Remover Manufacturer Qualifications: A firm regularly engaged in producing masonry paint removers that have been used for similar applications with successful results, and with factory-authorized service representatives who are available for consultation and Project-site inspection, preconstruction product testing, and on-site assistance.
- D. Chemical-Cleaner Manufacturer Qualifications: A firm regularly engaged in producing masonry cleaners that have been used for similar applications with successful results, and with factory-authorized service representatives who are available for consultation and Project-site inspection, preconstruction product testing, and on-site assistance.
- E. Quality-Control Program: Prepare a written quality-control program for this Project to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging masonry. Include provisions for supervising performance and preventing damage.
- F. Cleaning Program: Prepare a written cleaning program that describes cleaning process in detail, including materials, methods, sequence, and equipment to be used; protection of surrounding materials; and control of runoff during operations.
 - 1. If materials and methods other than those indicated are proposed for any phase of cleaning work, add to the quality-control program a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project.
- G. Mockups: Prepare mockups of cleaning on existing surfaces to demonstrate aesthetic effects and to set quality standards for materials and execution.
 - 1. Cleaning: Clean an area approximately 3ft by 3 ft (9 ft sq. ft.) where indicated by architect for each type of masonry, surface condition, and products.
 - a. Test cleaners and methods on samples of adjacent materials for possible adverse reactions. Do not test cleaners and methods known to have deleterious effect.
 - b. Allow a waiting period of not less than seven days after completion of sample cleaning to permit a study of sample panels for negative reactions.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.10 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified historic treatment specialist or one or more chemical-cleaner and paint-remover manufacturers to perform preconstruction testing on masonry surfaces.
 - 1. Use test areas as indicated and representative of proposed materials and existing construction.
 - 2. Propose changes to materials and methods to suit Project.

1.11 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit masonry cleaning work to be performed according to product manufacturers' written instructions and specified requirements.
- B. Clean masonry surfaces only when air temperature is 40 deg F (4 deg C) and above and is predicted to remain so for at least seven days after completion of cleaning.

1.12 WARRANTIES

- A. Cleaning Warranty: Cleaning procedures shall be warranted for a period of two years against harm to substrate (masonry and mortar) or to adjacent materials including, but not limited to, discoloration of substrate from improper procedures or usage, chemical damage from inadequate rinse procedures, and abrasive damage from improper procedures.

PART 2 - PRODUCTS

2.1 PAINT REMOVERS

- A. Solvent-Type Paste Paint Remover: Manufacturer's standard water-rinsable, solvent-type paste or gel formulation, for removing paint from masonry.
 - 1. Basis-of-Design Products: Subject to compliance with requirements, PROSOCO, Inc.; Sure Klean Fast Acting Stripper, or comparable product by one of the following:
 - a. Diedrich Technologies Inc., a division of Sandell Construction Solutions; 505 Special Coatings Stripper.
 - b. Hydrochemical Techniques, Inc.; HydroClean HT-300 Solvent Paint Remover.
 - c. Low-Odor, Solvent-Type Paste Paint Remover: Manufacturer's standard low-odor, water-rinsable, solvent-type paste, gel, or foamed emulsion formulation for removing paint from masonry; and containing no methanol or methylene chloride.
 - d. Basis-of-Design Products: Subject to compliance with requirements, PROSOCO, Inc.; Enviro Klean SafStrip or Enviro Klean SafStrip 8, or comparable product by one of the following:
 - e. ABR Products, Inc.; ABR Citrus Paint Removers or Super Bio Strip Gel.
 - f. Dumond Chemicals, Inc.; Peel Away 7 without paper covering, Smart Strip or Smart Strip Pro.
 - g. EaCo Chem, Inc.; InStrip.
 - h. Covered, Solvent-Type Paste Paint Remover: Manufacturer's standard, low-odor, covered, water-rinsable, solvent-type paste or gel formulation for removing paint from masonry; and containing no methanol or methylene chloride.
 - 2. Basis-of-Design Products: Subject to compliance with requirements, PROSOCO, Inc.; Enviro Klean Safety Peel 1, or comparable product by one of the following:
 - a. Dumond Chemicals, Inc.; Peel Away 6 or Peel Away 7.

2.2 CLEANING MATERIALS

- A. Water: Potable.
- B. Hot Water: Water heated to a temperature of 140 to 160 deg F (60 to 71 deg C).
- C. Detergent Solution, Job Mixed: Solution prepared by mixing 2 cups (0.5 L) of tetrasodium pyrophosphate (TSPP), 1/2 cup (125 mL) of laundry detergent, and 20 quarts (20 L) of hot water for every 5 gal. (20 L) of solution required.

- D. Mold, Mildew, and Algae Remover, Job Mixed: Solution prepared by mixing 2 cups (0.5 L) of tetrasodium pyrophosphate (TSPP), 5 quarts (5 L) of 5 percent sodium hypochlorite (bleach), and 15 quarts (15 L) of hot water for every 5 gal. (20 L) of solution required.
 - E. Nonacidic Gel Cleaner: Manufacturer's standard gel formulation, with pH between 6 and 9, that contains detergents with chelating agents and is specifically formulated for cleaning masonry surfaces.
 - 1. Basis of Design Products: Subject to compliance with requirements, PROSOCO, Inc.; Sure Klean 942 Limestone & Marble Cleaner, or comparable product by one of the following:
 - a. Dumond Chemicals, Inc.; Safe n' Easy Ultimate Stone and Masonry Cleaner.
 - b. Price Research, Ltd.; Price Marble Cleaner-Gel.
 - c. Nonacidic Liquid Cleaner: Manufacturer's standard mildly alkaline liquid cleaner formulated for removing mold, mildew, and other organic soiling from ordinary building materials, including polished stone, stone masonry, aluminum, plastics, and wood.
 - 2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABR Products, Inc.; Building Wash 3.
 - b. Cathedral Stone Products, Inc.; D/2 Biological Solution.
 - c. Diedrich Technologies Inc., a division of Sandell Construction Solutions; Diedrich 910PM Polished Marble/Granite Cleaner.
 - d. Dumond Chemicals, Inc.; Safe n' Easy Architectural Cleaner/Restorer or Safe n' Easy Limestone Cleaner.
 - e. Hydrochemical Techniques, Inc.; HydroClean HT-700 Polished Marble & Granite Cleaner.
 - f. Price Research, Ltd.; Price Non-Acid Masonry Cleaner.
 - g. PROSOCO, Inc.; Stand Off All Surface Cleaner or Stand Off Liquid Marble Cleaner.
- 2.3 ACCESSORY MATERIALS
- A. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, glazed masonry, and polished stone surfaces from damaging effects of acidic and alkaline masonry cleaners.
 - 1. Basis of Design Products: Subject to compliance with requirements, PROSOCO, Inc.; Sure Klean Strippable Masking, or comparable product by one of the following:
 - a. ABR Products, Inc.; ABR Rubber Mask.
 - b. Price Research, Ltd.; Price Mask.
 - B. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:
 - 1. Previous effectiveness in performing the work involved.
 - 2. Minimal possibility of damaging exposed surfaces.
 - 3. Consistency of each application.
 - 4. Uniformity of the resulting overall appearance.
 - 5. Do not use products or tools that could do the following:
 - a. Remove, alter, or harm the present condition or future preservation of existing surfaces, including surrounding surfaces not in contract.
 - b. Leave residue on surfaces.

PART 3 - EXECUTION

3.1 CLEANING MASONRY, GENERAL

- A. Historic materials shall not be damaged or marred in the process of cleaning. Cleaning shall conform to ASTM C 1515.
- B. Cleaning Appearance Standard: Cleaned surfaces are to have a uniform appearance as viewed from 20 feet (6 m) away by Architect.

- C. Coordinate masonry cleaning with hazardous materials abatement work requirements and procedures.
- D. Temporarily caulk or otherwise protect open joints to prevent water and cleaner intrusion into the interior of the structure from pressure spraying.
- E. Protect non-masonry materials and severely deteriorated masonry by approved methods prior to initiation of cleaning operations.
- F. Masonry cleaning shall remove all organic and inorganic contaminants from the surface and pores of the substrate, returning the masonry to its natural color. Surfaces shall be evenly cleaned with no evidence of streaking or bleaching. The cleaning process shall not affect the density, porosity, or color of the masonry or mortar.
- G. Cleaned masonry shall have a neutral pH. Use the gentlest methods possible for cleaning historic masonry to achieve the desired results. Make test patches to determine a satisfactory cleaning result.
- H. Cleaning shall proceed in an orderly manner, working from top to bottom of each scaffold width and from one end of each elevation to the other. Perform cleaning in a manner which results in uniform coverage of all surfaces, including corners, moldings, interstices and which produces an even effect without streaking or damage to masonry.
- I. The cleaning materials, equipment, and methods shall not result in staining, erosion, marring, or other damage to the surfaces of the structure. Following an initial inspection and evaluation of the structure and surfaces, give the structure a surface cleaning which shall be completed prior to start of repair work, and sampling and testing of mortars. The work shall provide for the complete cleaning of all exterior masonry surfaces of the structures, removing all traces of moss, dirt, and other contaminants to allow determination of the masonry's color and shades, finish and texture, and other properties.
- J. Following completion of the surface cleaning of the structure (or side of structure) the masonry shall be dried prior to the start of any repair work.
- K. The following sequence of methods shall be used to determine the least aggressive, effective cleaning method:
 - 1. Water with brushes.
 - 2. Water with mild soap.
 - 3. Water with sodium hypochlorite (household bleach).
 - 4. Water with stronger soap plus vinegar (but not on calcareous masonry).
 - 5. Stronger chemical cleaners, only when above methods are determined to be ineffective by the Architect.
- L. Acidic chemical cleaners shall not be used on limestone, marble, concrete and other calcareous (calcium containing) masonry materials.
- M. Use only those cleaning methods indicated for each masonry material and location.
 - 1. Brushes: Do not use wire brushes or brushes that are not resistant to chemical cleaner being used.
 - 2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that cleaning methods do not damage masonry.
 - a. Equip units with pressure gauges.
 - b. For chemical-cleaner spray application, use low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with nozzle having a cone-shaped spray.
 - c. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
 - d. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F (60 and 71 deg C) at flow rates indicated.
 - e. For steam application, use steam generator capable of delivering live steam at nozzle.
 - f. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces, including corners, moldings, and interstices, and that produces an even effect

without streaking or damaging masonry surfaces. Keep wall wet below area being cleaned to prevent streaking from runoff.

- N. Perform additional general cleaning, paint and stain removal, and spot cleaning of small areas that are noticeably different when viewed according to the "Cleaning Appearance Standard" Paragraph above, so that cleaned surfaces blend smoothly into surrounding areas.
- O. Water Application Methods:
 - 1. Water-Soak Application: Soak masonry surfaces by applying water continuously and uniformly to limited area for time indicated. Apply water at low pressures and low volumes in multiple fine sprays using perforated hoses or multiple spray nozzles. Erect a protective enclosure constructed of polyethylene sheeting to cover area being sprayed.
 - 2. Water-Spray Applications: Unless otherwise indicated, hold spray nozzle at least 12 inches (300 mm) from masonry surface, and apply water in horizontal back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.
- P. Chemical-Cleaner Application Methods: Apply chemical cleaners to masonry surfaces according to chemical-cleaner manufacturer's written instructions. Do not allow chemicals to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.
- Q. Rinse off chemical residue and soil by working upward from bottom to top of each treated area at each stage or scaffold setting. Periodically during each rinse, test pH of rinse water running off of cleaned area to determine that chemical cleaner is completely removed.
 - 1. Apply neutralizing agent and repeat rinse if necessary to produce tested pH of between 6.7 and 7.5.
- R. After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

3.2 PRELIMINARY CLEANING

- A. Removing Plant Growth: Completely remove visible plant, moss, and shrub growth from masonry surfaces. Carefully remove plants, creepers, and vegetation by cutting at roots and allowing remaining growth to dry as long as possible before removal. Remove loose soil and plant debris from open masonry joints to whatever depth they occur.
- B. Preliminary Cleaning: Before beginning general cleaning, remove extraneous substances that are resistant to planned cleaning methods. Extraneous substances include paint, and calking.
 - 1. Carefully remove heavy accumulations of rigid materials from masonry surface with flat palette knife, and stiff nylon or natural fiber brushes. Do not scratch or chip masonry surface.
 - 2. Remove paint and calking with low-order, solvent-type paste paint remover or covered, solvent-type paste paint remover.
 - a. Comply with requirements in "Paint Removal" Article.
 - b. Repeat application up to two times if needed.

3.3 PAINT REMOVAL

- A. Paint-Remover Application, General: Apply paint removers according to paint-remover manufacturer's written instructions. Do not allow paint removers to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.
- B. Paint Removal with Solvent-Type Paste Paint Remover:
 - 1. Remove loose and peeling paint using low pressure water spray, scrapers, stiff natural-fiber bristle brushes, or a combination of these. Let surface dry thoroughly.
 - 2. Apply thick coating of paint remover to painted surface with natural-fiber cleaning brush, deep- nap roller, or large paint brush. Apply in one or two coats according to manufacturer's written instructions.
 - 3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
 - 4. Rinse with hot water applied by low pressure spray to remove chemicals and paint residue.
- C. Paint Removal with Covered, Solvent-Type Paste Paint Remover:

1. Apply with a brush, roller, or trowel, 1/16" to 1/8" thick. Do not dilute or alter. Apply and prepare per manufacturer's instructions.
2. Cover Safety Peel 1 with sheets of Enviro Klean OverCoat, printed side outward. Rub gently to remove air pockets and ensure smooth, overall adhesion.
3. Let Safety Peel 1 and OverCoat™ dwell at least two hours before evaluating their effectiveness. Some types and thicknesses of coatings may need dwell times of up to 24 hours. Multiple applications may also be necessary.
4. Remove and collect the paste, paper, and dissolved material by inserting a trowel, spatula or other paint scraping tool through the paste and lifting it from the surface. Remove as much as possible. Reapply as needed.
5. Rinse surface clean with water, preferably heated water, to improve removal effectiveness. Let cleaned surface dry thoroughly before any other treatment is applied. If residual product has dried on the surface, wet it down with warm water and keep it moist for 15 minutes. This makes it easier to rinse thoroughly with a pressure washer.
6. Dispose of paper, spent cleaner and dissolved coatings/contaminants according to local, state and federal regulations.

3.4 CLEANING STONE MASONRY

A. Cold-Water Soak:

1. Continue spraying until surface encrustation has softened sufficiently to permit its removal by water wash, as indicated by cleaning tests.
2. Remove soil and softened surface encrustation from surface with cold water applied by low-pressure spray.

B. Hot-Water Wash: Use hot water applied by low-pressure spray.

C. Detergent Cleaning:

1. Wet surface with hot water applied by low-pressure spray.
2. Scrub surface with detergent solution using medium-soft brushes until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from mortar joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.
3. Rinse with hot water applied by low pressure spray to remove detergent solution and soil.
4. Repeat cleaning procedure above, where required to produce cleaning effect established by mockup.

D. Mold, Mildew, and Algae Removal:

1. Wet surface with hot water applied by low-pressure spray.
2. Apply mold, mildew, and algae remover by brush or low-pressure spray.
3. Scrub surface with medium-soft brushes until mold, mildew, and algae are thoroughly dislodged and can be removed by rinsing. Use small brushes for mortar joints and crevices. Dip brush in mold, mildew, and algae remover often to ensure that adequate fresh cleaner is used and that surface remains wet.
4. Rinse with hot water applied by low pressure spray to remove mold, mildew, and algae remover and soil.
5. Repeat cleaning procedure above, where required to produce cleaning effect established by mockup.

E. Nonacidic Gel Chemical Cleaning:

1. Wet surface with hot water applied by low-pressure spray.
2. Apply gel cleaner in 1/8-inch (3-mm) thickness by brush, working into joints and crevices. Apply quickly and do not brush out excessively, so area is uniformly covered with fresh cleaner and dwell time is uniform throughout area being cleaned.
3. Let cleaner remain on surface for period recommended in writing by chemical-cleaner manufacturer and established by mockup.

4. Remove bulk of gel cleaner.
 5. Rinse with hot water applied by low pressure spray to remove chemicals and soil.
 6. Repeat cleaning procedure above, where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.
- F. Nonacidic Liquid Chemical Cleaning:
1. Wet surface with hot water applied by low-pressure spray.
 2. Apply cleaner to surface as directed by manufacturer with a brush or low-pressure spray.
 3. Let cleaner remain on surface for period recommended in writing by chemical-cleaner manufacturer and established by mockup.
 4. Rinse with hot water applied by low-pressure spray to remove chemicals and soil.
 5. Repeat cleaning procedure above, where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.
- G. One-Part Limestone Chemical Cleaning:
1. Wet surface with hot water applied by low-pressure spray.
 2. Apply cleaner to surface by brush or low-pressure spray.
 3. Let cleaner remain on surface for period recommended in writing by chemical-cleaner manufacturer and established by mockup.
 4. Immediately repeat application of one-part limestone cleaner as indicated above over the same area.
 5. Rinse with hot water applied by medium-pressure spray to remove chemicals and soil.
- 3.5 FINAL CLEANING
- A. Clean adjacent non-masonry surfaces of spillage and debris. Use detergent and soft brushes or cloths.
 - B. Remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.
 - C. Remove masking materials, leaving no residues that could trap dirt.
- 3.6 FIELD QUALITY CONTROL
- A. Architect's Project Representatives: Architect will assign Project representatives to help carry out Architect's responsibilities at the site, including observing progress and quality of portion of the Work completed. Allow Architect's Project representatives use of lift devices and scaffolding, as needed, to observe progress and quality of portion of the Work completed.
 - B. Notify Architect's Project representatives in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until Architect's Project representatives have had reasonable opportunity to make inspections and observations of work areas at lift device or scaffold location.

END OF SECTION 04 03 10

SECTION 04 03 42 – HISTORIC STONE MASONRY REPAIR AND REPOINTING

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 historic treatment work consisting of repairing, reconstructing, and repointing historic stone masonry assemblies as follows:
1. Repairing historic stone masonry walls and assemblies, including replacing or reinstalling whole and partial units.
 2. Reconstructing partial or whole sections of deteriorated historic stone masonry walls and assemblies with salvaged historic and new masonry materials.
 3. Repointing historic stone masonry joints with appropriate and compatible mortar material.
- B. Related Requirements:
1. Section 01 35 91 "Historic Treatment Procedures."
 2. Section 02 42 96 "Historic Removal and Dismantling" for historic removal and dismantling work.
 3. Section 03 30 00 "Cast-in-place Concrete" for new concrete footings and retaining walls for reconstructing partial or whole sections of deteriorated historic stone masonry walls and assemblies.
 4. Section 04 40 310 "Historic Stone Masonry Cleaning" for cleaning treatments for historic stone masonry walls and assemblies.
 5. Section 04 05 15 "Preparing Lime Mortars" for guidance on preparing lime mortar for repointing and repairing designated historic stone masonry in which the existing construction consists of lime mortar.
 6. Section 04 30 00 "Natural Stone Veneer" for new stone masonry walls and assemblies adjacent to historic stone masonry walls and assemblies.
 7. Section 05 05 19 "Post-installed Concrete and Masonry Anchors" for structural masonry anchors for reconstructing partial or whole sections of deteriorated historic stone masonry walls and assemblies.

1.3 UNIT PRICES

- A. Work of this Section is affected by unit prices specified in Section 012200 "Unit Prices."

1.4 DEFINITIONS

- A. Low-Pressure Spray: 100 to 400 psi (690 to 2750 kPa); 4 to 6 gpm (0.25 to 0.4 L/s).
- B. Face Bedding: Setting of historic stone masonry with the rift or natural bedding planes (strata) vertical and parallel to the wall plane rather than horizontal or "naturally bedded," which holds bedding planes together by gravity.
- C. Rebuilding (Setting) Mortar: Mortar used to set and anchor masonry in a structure, distinct from pointing mortar installed after masonry is set in place.
- D. Rift: The most pronounced direction of splitting or cleavage of stone masonry material.
- E. Stone Masonry Terminology: ASTM C 119.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at the General Contractor's field office adjacent to project site.

1. Review minutes of Preliminary Historic Treatment Conference that pertain to stone masonry historic treatment and repair.
2. Review methods and procedures related to repairing historic stone masonry including, but not limited to, the following:
 - a. Verify historic treatment specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, material application, sequencing, tolerances, and required clearances.
 - c. Quality-control program.
 - d. Fire-protection plan, if applicable.
 - e. Stone masonry historic treatment program.
 - f. Coordination with City of San Antonio's Parks and Recreation Department.

1.6 SEQUENCING AND SCHEDULING

- A. Order sand and gray portland cement, if any, for colored mortar immediately after approval of mockups. Take delivery of and store at Project site a quantity sufficient to complete Project.
- B. Work Sequence: Perform stone masonry historic treatment work in the following sequence, which includes work specified in this and other Sections:
- C. Remove plant growth.
 1. Inspect for open mortar joints and repair before cleaning to prevent the intrusion of water and other cleaning materials into the wall.
 2. Remove paint, if present, from stone masonry surfaces. (Refer to section 040310 "Historic Stone Masonry Cleaning")
 3. Clean stone masonry. (Refer to section 040310 "Historic Stone Masonry Cleaning")
 4. Rake out mortar from joints surrounding stone masonry to be replaced and from joints adjacent to stone masonry repairs along joints.
 5. Repair stone masonry, including replacing existing stone masonry with new stone masonry. If required, repair backup masonry or provide structural concrete footings and retaining walls where indicated in drawings.
 6. Rake out mortar from joints to be repointed.
 7. Point mortar and sealant joints.
 8. After repairs and repointing have been completed and cured, perform a final cleaning to remove residues from this work.
- D. Scaffolding, if required, shall be self-supportive and not anchored to historic materials or features. Coordinate scaffolding with other work.

1.7 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 1. Include recommendations for product application and use. Include test data substantiating that products comply with requirements.
- C. Shop Drawings:
- D. Include plans, elevations, sections, and locations of stone masonry repair work on the structure.
 1. Indicate complete dimensions and size range for new stone masonry units and their jointing, showing relation of existing to new units.
 2. Show partial replacement stone masonry units (dutchmen), if applicable.
 3. Indicate setting number of each new stone masonry unit and its location on the structure in annotated plans and elevations.
 4. Show provisions for expansion joints or other sealant joints, as required.
 5. Show provisions for flashing, lighting fixtures, conduits, railings, and weep holes as required.

6. Show replacement and repair anchors, including drilled-in pins. Include details of anchors within individual stone masonry units, with locations of anchors and dimensions of holes and recesses in stone masonry required for anchors, including direction and angle of holes for pins as required.
 7. Show locations of scaffolding and points of scaffolding in contact with masonry. Include details of each point of contact or anchorage, if required. Direct contact of scaffolding with historic masonry materials should be avoided, if possible.
 - E. Samples for Initial Selection for each exposed product or accessory and for each color and texture specified for the following:
 1. Colored Mortar: Submit sets of mortar that will be left exposed in the form of sample mortar strips, 6 inches (150 mm) long by 1/4 inch (6 mm) wide, set in aluminum or plastic channels.
 - a. Have each set contain a close color range of at least three Samples of different mixes of colored sands and cements that produce a mortar matching the existing, cleaned mortar when cured and dry.
 - b. Submit with precise measurements on ingredients, proportions, gradations, and sources of colored sands from which each Sample was made.
 - c. Each type of sand used for mortar; minimum 8 oz. (240 mL) of each in plastic screw-top jars.
 - d. For blended sands, provide Samples of each component and blend. Identify blend ratio.
 - e. Identify sources, both supplier and quarry, of each type of sand.
 2. Patching Compound: Submit sets of patching compound Samples in the form of plugs (patches in drilled holes) in sample units of stone masonry representative of the range of stone masonry colors on the building.
 - a. Have each set contain a close color range of at least three Samples of different mixes of patching compound that matches the variations in existing stone masonry when cured and dry.
 3. Include similar Samples of accessories involving color selection.
 - F. Samples for Verification: For the following:
 1. Each type of replacement stone masonry. Include sets of Samples to show full range of color, texture, grain, veining, and finish to be expected. Provide sets of at least three 12-by-12-inch (300-by-300-mm) Samples for each type, but no fewer than necessary to indicate full range and the proportion of variations within range.
 2. Each type of patching compound in form of briquettes, at least 3 inches (75 mm) long by 1-1/2 inches (38 mm) wide. Document each Sample with manufacturer and stock number or other information necessary to order additional material.
 3. Each type of adhesive.
 4. Accessories: Each type of anchor, accessory, and miscellaneous support.
- 1.8 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For historic treatment specialists, including field supervisors and workers, testing service.
 - B. Preconstruction Test Reports: For existing stone masonry and mortar and replacement stone masonry.
 - C. Quality-control program.
 - D. Stone masonry historic treatment program.
- 1.9 QUALITY ASSURANCE
- A. Basis for Standard of Care: U.S. Department of the Interior – National Park Service – Standards and Guidelines.
 - B. Historic Treatment Specialist Qualifications: A qualified historic stone masonry repair specialist. Experience installing standard unit masonry or new stone masonry is insufficient experience for stone masonry historic treatment work.

1. A list of similar jobs, completed within the last seven years, shall be provided. Identify when, where, and for whom the work was performed.
 2. Historic Treatment Specialist Firms: Subject to compliance with requirements, firms that may provide historic stone masonry repair include, but are not limited to, the following:
 - a. Curtis Hunt Restorations, Inc., 14915 Cassiano Road, Elmendorf, Texas 78112, tel. 210.635.8872, fax 210.635.7739, email huntrestorations@yahoo.com.
 - C. Stone Masonry Historic Treatment Program: Prepare a written, detailed description of materials, methods, equipment, and sequence of operations to be used for each phase of the historic treatment work including protection of surrounding materials and Project site.
 1. Prepare a written quality-control program for this Project to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging masonry. Include provisions for supervising worker performance and preventing damage.
 2. Include methods for keeping exposed mortar damp during curing period.
 3. If materials and methods other than those indicated are proposed for any phase of historic treatment work, add to the quality-control program a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project.
 - D. Mockups: Prepare mockups of historic treatment on new mockup panels to demonstrate aesthetic effects and to set quality standards for materials and execution and for fabrication and installation. No masonry or mortar shall be used in the work until the samples and the represented mixture have been approved.
 1. Stone Masonry Repair and Repointing: Prepare sample areas for each type of stone masonry indicated to have repair work performed. If not otherwise indicated, size each mockup not smaller than two adjacent whole units or approximately 48 inches (1200 mm) in least dimension. Construct sample areas in locations in existing walls where directed by Architect unless otherwise indicated. Demonstrate quality of materials, workmanship, and blending with existing work. Include the following, if applicable, as a minimum:
 - a. Replacement: Four stone masonry units replaced.
 - b. Partial Stone Replacement: Two partial stone replacements (dutchman repairs).
 - c. Crack Injection: Apply crack injection in two separate areas, each approximately 36 inches (900 mm) long.
 - d. Patching: Three small holes at least 1 inch (25 mm) in diameter.
 2. Repointing: Rake out joints in two separate areas, each approximately 36 inches (900 mm) high by 48 inches (1200 mm) wide for each type of repointing required and repoint one of the areas.
 3. Stone Masonry Reconstruction: Prepare free-standing walls of each type of stone masonry indicated for reconstruction where directed by Architect unless otherwise indicated. Demonstrate quality of materials, workmanship, and compatibility with existing work.
 - a. Coordinate mockup construction with requirements found in Section 033000 "Cast-in-place Concrete" for footings, retaining walls, and structural masonry anchors for reconstructing partial or whole sections of deteriorated historic stone masonry walls.
 - b. Masonry Reconstruction Mockups are not to be incorporated into the completed Work, but shall remain undisturbed until time of Substantial Completion. Upon Substantial Completion, remove all Masonry Reconstruction Mockups completely.
 - E. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- 1.10 PRECONSTRUCTION TESTING
- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on masonry materials as follows:

- B. Provide test specimens as indicated and representative of proposed materials and existing construction.
 - 1. Replacement Stone Masonry: Test each proposed type of replacement stone masonry, according to ASTM C 170/C 170M for compressive strength, wet and dry, perpendicular, and parallel to rift; ASTM C 99/C 99M for modulus of rupture, wet and dry, perpendicular, and parallel to rift; and ASTM C 97/C 97M for absorption and bulk specific gravity.
 - 2. Existing Stone Masonry: Test each type of existing masonry indicated for replacement, according to ASTM C 170/C 170M for compressive strength, wet and dry, perpendicular, and parallel to rift; ASTM C 99/C 99M for modulus of rupture, wet and dry, perpendicular, and parallel to rift; and ASTM C 97/C 97M for absorption and bulk specific gravity. Carefully remove two existing stone masonry units from locations designated by Architect. Take testing samples from these units.
 - 3. Existing Mortar: Test according to ASTM C 295, ASTM C 1324, and acid reduction methods, modified as agreed by testing service and Architect for Project requirements, to determine proportional composition of original ingredients, sizes and colors of aggregates, and approximate strength. Use x-ray diffraction, infrared spectroscopy, and differential thermal analysis to supplement microscopical methods, as required, to accurately characterize the existing mortar types. Carefully remove existing mortar from within joints at five locations designated by Architect.
 - C. MORTAR ANALYSIS
 - 1. Test and analyze existing original historic mortar before repointing in order to provide a match with the new repointing mortar.
 - 2. Historic mortars are usually softer than newer mortars, often using lime as a binder rather than cement. Lime for repointing mortar shall conform to ASTM C 207, Type S, unless otherwise specified.
 - 3. Full laboratory analysis of the existing mortar shall conform to ASTM C 1324.
 - D. TAKING AND PREPARATION OF SAMPLES
 - 1. Take and analyze samples of unweathered original historic mortar and different type of mortar in the structure to match the new mortar to be used for repointing.
 - 2. Four samples of each type of mortar to be matched shall be removed with a hand chisel from several locations on each building. Set aside the largest sample for comparison with the repointing mortar.
 - 3. The remaining samples shall be broken apart with a wooden mallet, powdering them into their constituent parts.
 - 4. Temporary Patch: As directed by Architect, provide temporary materials followed by permanent repairs at locations from which existing samples were taken, if applicable.
- 1.11 DELIVERY, STORAGE, AND HANDLING
- A. Deliver stone masonry units to Project site strapped together in suitable packs or pallets or in heavy-duty crates and protected against impact and chipping.
 - B. Deliver packaged materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.
 - C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
 - D. Store hydrated lime in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two days.
 - E. Store lime putty covered with water in sealed containers.
 - F. Store sand where grading and other required characteristics can be maintained, and contamination avoided.
 - G. Handle stone masonry to prevent overstressing, chipping, defacement, and other damage.

1.12 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit repair work to be performed according to product manufacturers' written instructions and specified requirements.
- B. Temperature Limits, General: Repair stone masonry units only when air temperature is between 40 and 90 deg F (4 and 32 deg C) and is predicted to remain so for at least seven days after completion of the Work unless otherwise indicated.
- C. Cold-Weather Requirements: Comply with the following procedures for stone masonry repair unless otherwise indicated:
- D. When air temperature is below 40 deg F (4 deg C), heat mortar ingredients, repair materials, and existing stone masonry to produce temperatures between 40 and 120 deg F (4 and 49 deg C).
 - 1. When mean daily air temperature is below 40 deg F (4 deg C), provide enclosure and heat to maintain temperatures above 32 deg F (zero deg C) within the enclosure for seven days after repair.
- E. Hot-Weather Requirements: Protect stone masonry repair when temperature and humidity conditions produce excessive evaporation of water from mortar and patching materials. Provide artificial shade and wind breaks and use cooled materials as required to minimize evaporation. Do not apply mortar to substrates with temperatures of 90 deg F (32 deg C) and above unless otherwise indicated.
- F. For manufactured repair materials, perform work within the environmental limits set by each manufacturer.

1.13 WARRANTIES

- A. Repair Warranty: Repair procedures, including repointing, shall be warranted for a period of two years against: discoloration or mismatch of new mortar to adjacent original historic mortar, discoloration, or damage to masonry from improper mortar clean-up, loss of bond between masonry and mortar, fracturing of masonry edges from improper mortar joint preparation procedures or improper mortar formulation, and occurrence of efflorescence.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Source Limitations: Obtain each type of material for repairing historic masonry (stone, cement, sand, etc.) from single source with resources to provide materials of consistent quality in appearance and physical properties.
- B. Materials, physical and chemical properties, and composition of masonry and mortar used in renovation work shall match that of original existing masonry and mortar to be repaired, unless samples and testing determine that existing mixtures and materials are faulty or nonperforming.

2.2 MASONRY MATERIALS

- A. Stone Masonry Matching Existing: Provide natural building stone of variety, color, texture, grain, veining, finish, size, and shape to match existing stone masonry and with physical properties within 10 percent of those determined from preconstruction testing of selected existing stone masonry.
- B. Salvaged Stone Masonry: A limited quantity of loose historic stone masonry is available on site or from disassembly of failing masonry walls for reuse, if material testing of representative samples of the salvaged are demonstrated meet preconstruction testing requirements.

2.3 MORTAR MATERIALS

- A. Portland Cement: ASTM C 150/C 150M, Type I or Type II; white where required for color matching of mortar.

- B. Provide cement containing not more than 0.60 percent total alkali when tested according to ASTM C 114.
 - C. Hydrated Lime: ASTM C 207, Type S.
 - D. Mortar Sand: ASTM C 144 unless otherwise indicated.
 - 1. Match size, texture, and gradation of existing mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match.
 - 2. Colored Mortar: Provide natural sand of color necessary to produce required mortar color.
 - 3. For exposed mortar, provide sand with rounded edges.
 - E. Water: Potable.
- 2.4 MORTAR MIXES
- A. Refer to Section 040515 "Preparing Lime Mortars for Masonry" for suggested mortar mixes, subject to verification through Preconstruction Testing.
- 2.5 REPAIR MATERIALS
- A. Masonry and mortar materials used for repair and renovation shall match the original existing historic materials as closely as possible in composition, color, texture, strength, size, finishing and porosity based on results of mortar materials testing.
 - B. Mortar Patching Mix For Epoxy Injection:
 - 1. Use salvaged mortar ground into powder consistency and mix into manufacturer's epoxy masonry adhesive used for both epoxy injection.
- 2.6 EPOXY MASONRY ADHESIVE FOR EPOXY INJECTION
- A. Manufacturer: Edison Coatings; 3 Northwest Drive; Plainville, CT 06062; www.edisoncoatings.com.
 - 1. Flexi-seal 510 for cracks 1/16" in width or smaller.
 - 2. Flexi-seal 510-U for cracks larger than 1/16" in width, and a maximum width of 1/8".
- 2.7 ACCESSORY MATERIALS
- A. Masonry Anchors and Pins: Fabricate anchors, if required, from Type 304 stainless steel.
 - B. Masking Tape: Non-staining, non-absorbent material; compatible with mortar, joint primers, sealants, and surfaces adjacent to joints; and that easily comes off entirely, including adhesive.
 - C. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:
 - 1. Previous effectiveness in performing work involved.
 - 2. Minimal possibility of damaging exposed surfaces.
 - 3. Consistency of each application.
 - 4. Uniformity of the resulting overall appearance.
 - 5. Do not use products or tools that could do the following:
 - a. Remove, alter, or harm the present condition or future preservation of existing surfaces, including surrounding surfaces not in contract.
 - b. Leave residue on surfaces.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Prevent mortar from staining face of surrounding stone masonry and other surfaces.
- B. Cover sills, ledges, and other projecting items to protect them from mortar droppings.
 - 1. Keep wall area wet below rebuilding and pointing work to discourage mortar from adhering.
 - 2. Immediately remove mortar splatters in contact with exposed masonry and other surfaces.

3.2 STONE MASONRY REPAIR, GENERAL

- A. Repair Appearance Standard: Repaired surfaces are to have a uniform appearance as viewed from 20 feet (6 m) away by Architect.
- B. Repaired surfaces shall match adjacent existing surfaces in all respects.
- C. Masonry repair shall proceed only after the cause of deterioration has been identified and corrected.
- D. Masonry repair shall proceed only after the area to be repaired has been cleaned.
- E. The materials, methods and equipment proposed for use in the repair work shall be demonstrated in test panels.
- F. The location, number, size and completed test panels shall be subject to approval.
- G. Use products in accordance with the manufacturer's instructions.
- H. The exposed surfaces of masonry and mortar repair shall match the finish, color, texture, and surface detail of the original surface.
- I. Mechanical finishing and texturing may be required to produce the required finish and appearance.
- J. The finishing and texturing shall conceal bond lines between the repaired area and adjacent surfaces. The texturing shall provide replication of all surface details, including tooling and machine marks.
- K. The equipment used in finishing and texturing shall be a low-impact energy type which will not weaken the patch or damage the patch bond and the adjacent concrete.

3.3 STONE MASONRY REPLACEMENT, GENERAL

- A. Replace masonry with salvaged stone from disassembled walls and approved sources.
- B. If a few isolated masonry units are to be replaced, remove each without disturbing the surrounding masonry. Deteriorated masonry units and mortar requiring replacement shall be removed by hand chiseling.
- C. Adjoining masonry units shall not be damaged during the removal of deteriorated units and mortar.
- D. Test the new element for fitting into its space without mortar. If wedges are used to support and align the new unit, they shall be covered with at least 1-1/2 inches of mortar when pointing is complete.
- E. Cover the four sides and back of the space with sufficient mortar to ensure that there will be no air spaces when the new unit is set. The new unit shall be lined up and set by tapping it into place with a wooden or rubber mallet.
- F. Align face of new unit with that of existing masonry.
- G. Joints shall be repointed to match the rest of the wall after new units have been properly installed and adjusted.
- H. Clean replacement areas with a non-metallic brush and water to remove excess mortar.

3.4 STONE REMOVAL AND REPLACEMENT

- A. At locations indicated, remove stone that has deteriorated or is damaged beyond repair or is to be reused. Carefully remove entire units from joint to joint, without damaging surrounding masonry, in a manner that permits replacement with full-size units.
- B. Support and protect remaining masonry that was supported by removed stone.
- C. Maintain flashing, reinforcement, lintels, and adjoining construction in an undamaged condition.
- D. Notify Architect of unforeseen detrimental conditions including voids, cracks, bulges, loose units in existing stone or unit masonry backup, rotted wood, rusted metal, and other deteriorated items.
- E. Remove in an undamaged condition as many whole stone units as possible. Remove mortar and sealant from surfaces of removed stones.
- F. Clean masonry surrounding removal areas by removing mortar, dust, and loose particles in preparation for stone replacement.
- G. Replace removed damaged stone with other removed stone in good condition, where possible, matching existing stone. Do not use broken units unless they can be cut to usable size.

- H. Rift: Do not allow face bedding of stone. Before setting, inspect to verify that each stone has been cut so that, when it is set in final position, the rift or natural bedding planes are predominantly horizontal. Reject stone with vertical bedding planes except as required for arches, lintels, and copings.
 - I. Install replacement stone into bonding and coursing pattern of existing stone. If cutting is required, use a motor-driven saw designed to cut stone with clean, sharp, unchipped edges. Finish edges to blend with appearance of edges of existing stone.
 - 1. Maintain joint width for replacement stone to match existing joints.
 - 2. For narrow joints, use setting buttons or shims to set stone accurately spaced with uniform joints.
 - J. Set replacement stone with rebuilding (setting) mortar and with completely filled bed, head, and collar joints. Butter vertical joints for full width before setting and set units in full bed of mortar unless otherwise indicated.
 - 1. Replace existing anchors, if any, with new anchors of size and type indicated in Structural Engineer's drawings and specifications.
 - 2. Tool exposed mortar joints in repaired areas to match joints of surrounding existing stonework.
 - K. When mortar is sufficiently hard to support units, remove shims and other devices interfering with pointing of joints.
 - L. Curing: Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours, including weekends and holidays.
 - 1. Hairline cracking within the mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.
- 3.5 PARTIAL STONE REPLACEMENT
- A. Remove defective portion of existing stone unit (backing stone). Carefully remove defective portion of stone by making vertical and horizontal saw cuts at face of backing stone and removing defective material to depth required for fitting partial replacement (dutchman).
 - 1. Make edges of backing stone at cuts smooth and square to each other and to finished surface; essentially rectangular. Make back of removal area flat and parallel to stone face.
 - 2. Do not overcut at corners and intersections. Hand trim to produce clean sharp corners with no rounding and no damage to existing work to remain.
 - 3. If backing stone becomes further damaged, remove damaged area and enlarge partial replacement as required.
 - B. Cut and trim partial replacement to accurately fit area where material was removed from backing stone. Fabricate to size required to produce joints between partial replacement and backing stone of no more than 1/8 inch (3 mm) in width, and to produce joints between partial replacement and other stones that match existing joints between stones.
 - C. Concealed Pinning: Before applying adhesive, prepare for concealed mechanical anchorage consisting of 1/4-inch- (6-mm-) diameter, plain stainless-steel pins set into 1/4-inch- (6-mm-) diameter holes drilled into backing stone and into, but not through, the partial replacement. Center and space pins between 3 and 5 inches (75 and 125 mm) apart and at least 2 inches (50 mm) from any edge. Insert pins at least 2 inches (50 mm) in backing stone and 2 inches (50 mm) in partial replacement, but no closer than 3/4 inch (19 mm) from exposed face of partial replacement.
 - D. Apply stone-to-stone adhesive according to adhesive manufacturer's written instructions. Coat bonding surfaces of backing stone and partial replacement, completely filling all crevices and voids.
 - E. Apply partial replacement while adhesive is still tacky and hold securely in place until adhesive has cured. Use shims, clamps, wedges, or other devices as necessary to align face of partial replacement with face of backing stone.
- 3.6 STONE PATCHING
- A. Patch the following stone units unless another type of repair or replacement is indicated:

1. Units indicated to be patched.
 2. Units with holes.
 3. Units with chipped edges or corners. Patch chipped edges or corners measuring over 3/4 inch (19 mm) in least dimension.
 4. Units with small areas of deep deterioration. Patch deep deteriorations measuring over 3/4 inch (19 mm) in least dimension and over 1/4 inch (6 mm) deep.
- B. Remove deteriorated material and remove adjacent material that has begun to deteriorate. Carefully remove additional material so patch does not have feathered edges but has square or slightly undercut edges on area to be patched and is at least 1/4 inch (6 mm) thick, but not less than as recommended in writing by patching compound manufacturer.
- C. Mask adjacent mortar joint or rake out for repointing if patch extends to edge of stone unit.
- D. Mix patching compound in individual batches to match each stone unit being patched.
- E. Brush-coat stone surfaces with slurry coat of patching compound according to manufacturer's written instructions.
- F. Place patching compound in layers as recommended in writing by patching compound manufacturer, but not less than 1/4 inch (6 mm) or more than 2 inches (50 mm) thick. Roughen surface of each layer to provide a key for next layer.
1. Simple Details: Trowel, scrape, or carve surface of patch to match texture and surrounding surface plane or contour of the stone. Shape and finish surface before or after curing, as determined by testing, to best match existing stone.
 2. Carved Details: Build patch up 1/4 inch (6 mm) above surrounding stone and carve surface to match adjoining stone after patching compound has hardened.
- G. Keep each layer damp for 72 hours or until patching compound has set.
- H. Remove and replace patches with hairline cracks or that show separation from stone at edges, and those that do not match adjoining stone in color or texture.
- 3.7 REPOINTING STONEMWORK
- A. Rake out and repoint joints to the following extent:
1. All joints in areas indicated on Drawings.
 2. Joints indicated as sealant-filled joints. Seal joints according to Section 079200 "Joint Sealants."
 3. Joints at locations of the following defects:
 - a. Holes and missing mortar.
 - b. Cracks that can be penetrated 1/4 inch (6 mm) or more by a knife blade 0.027 inch (0.7 mm) thick.
 - c. Cracks 1/8 inch (3 mm) or more in width and of any depth.
 - d. Hollow-sounding joints when tapped by metal object.
 - e. Eroded surfaces 1/4 inch (6 mm) or more deep.
 - f. Deterioration to point that mortar can be easily removed by hand, without tools.
 - g. Joints filled with substances other than mortar.
- B. Do not rake out and repoint joints where not required.
- C. Rake out joints as follows, according to procedures demonstrated in approved mockup:
1. Remove mortar from joints to depth of joint width plus 1/8 inch (3 mm) but not less than 3/4 inch (20 mm) or not less than that required to expose sound, unweathered mortar. Do not remove unsound mortar more than 2 inches (50 mm) deep; consult Architect for direction.
 2. Remove mortar from stone surfaces within raked-out joints to provide reveals with square backs and to expose stone for contact with pointing mortar. Brush, vacuum, or flush joints to remove dirt and loose debris.
 3. Do not spall edges of stone units or widen joints. Replace or patch damaged stone units as directed by Architect.
 - a. Cut out mortar by hand with chisel and resilient mallet. Do not use power-operated grinders without Architect's written approval based on approved quality-control program.

- D. Notify Architect of unforeseen detrimental conditions including voids in mortar joints, cracks, loose stone, rotted wood, rusted metal, and other deteriorated items.
 - E. Pointing with Mortar:
 - 1. Rinse joint surfaces with water to remove dust and mortar particles. Time rinsing application so, at time of pointing, joint surfaces are damp but free of standing water. If rinse water dries, dampen joint surfaces before pointing.
 - 2. Apply pointing mortar first to areas where existing mortar was removed to depths greater than surrounding areas. Apply in layers not greater than 3/8 inch (9 mm) until a uniform depth is formed. Fully compact each layer thoroughly and allow it to become thumbprint hard before applying next layer.
 - 3. After deep areas have been filled to same depth as remaining joints, point joints by placing mortar in layers not greater than 3/8 inch (9 mm). Fully compact each layer and allow it to become thumbprint hard before applying next layer. Where existing stone has worn or rounded edges, slightly recess finished mortar surface below face of stone to avoid widened joint faces. Take care not to spread mortar beyond joint edges onto exposed stone surfaces or to featheredge the mortar.
 - 4. When mortar is thumbprint hard, tool joints to match original appearance of joints as demonstrated in approved mockup. Remove excess mortar from edge of joint by brushing.
 - 5. Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours, including weekends and holidays.
 - a. Acceptable curing methods include covering with wet burlap and plastic sheeting, periodic hand misting, and periodic mist spraying using system of pipes, mist heads, and timers.
 - b. Adjust curing methods to ensure that pointing mortar is damp throughout its depth without eroding surface mortar.
 - 6. Hairline cracking within the mortar or mortar separation at edge of a joint is unacceptable. Remove mortar and repoint.
 - F. Where repointing work precedes cleaning of existing stone, allow mortar to harden at least 30 days before beginning cleaning work.
- 3.8 JOINT SEALING
- A. Provide joint sealing as specified in Section 07 0005 JOINT SEALERS.
- 3.9 FINAL CLEANING
- A. After mortar has fully hardened, thoroughly clean exposed stone surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes, and clean water applied by low-pressure spray.
 - 1. Do not use metal scrapers or brushes.
 - 2. Do not use acidic or alkaline cleaners.
 - B. Discolorations which cannot be removed by these procedures shall be considered defective work.
 - C. Perform cleaning work when temperature and humidity conditions allow the surfaces to dry rapidly.
 - D. Protect adjacent surfaces from damage during cleaning operations.
- 3.10 PROTECTION OF WORK
- A. Protect work against damage from subsequent operations.
- 3.11 DEFECTIVE WORK
- A. Defective work shall be repaired or replaced, as directed, using approved procedures.
- 3.12 FINAL INSPECTION
- A. Following completion of the work, inspect the structure for damage, staining, and other distresses. The patches shall be inspected for cracking, crazing, delamination, unsoundness, staining and other defects.

- B. The finish, texture, color and shade, and surface tolerances of the patches shall be inspected to verify that all requirements have been met.
- C. Repair surfaces exhibiting defects as directed.

3.13 MASONRY-WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess non-historic stone masonry materials are Contractor's property. Excess salvaged historic stone masonry materials shall remain on site and stockpiled where directed by the City of San Antonio's Parks and Recreation Department.
- B. Masonry Waste: Remove masonry waste and legally dispose of off City of San Antonio's property.

END OF SECTION 04 03 42

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Mortar for masonry.
- B. Grout for masonry.

1.2 RELATED REQUIREMENTS

- A. Section 042000 - Unit Masonry: Installation of mortar and grout.
- B. Section 042900 - Engineered Unit Masonry: Installation of mortar and grout.

1.3 REFERENCE STANDARDS

- A. ASTM C5 - Standard Specification for Quicklime for Structural Purposes; 2018.
- B. ASTM C91/C91M - Standard Specification for Masonry Cement; 2018.
- C. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2022a.
- D. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar; 2018.
- E. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.
- F. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes; 2018.
- G. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2019a, with Editorial Revision.
- H. ASTM C404 - Standard Specification for Aggregates for Masonry Grout; 2018.
- I. ASTM C476 - Standard Specification for Grout for Masonry; 2020.
- J. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry; 2020.
- K. ASTM C1019 - Standard Test Method for Sampling and Testing Grout for Masonry; 2020.
- L. ASTM C1072 - Standard Test Methods for Measurement of Masonry Flexural Bond Strength; 2019.
- M. ASTM C1314 - Standard Test Method for Compressive Strength of Masonry Prisms; 2021.
- N. ASTM C1714/C1714M - Standard Specification for Preblended Dry Mortar Mix for Unit Masonry; 2019a.
- O. ASTM E518/E518M - Standard Test Methods for Flexural Bond Strength of Masonry; 2021.
- P. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures; 2016.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Include design mix and indicate whether the Proportion or Property specification of ASTM C270 is to be used. Also include required environmental conditions and admixture limitations.

1.5 QUALITY ASSURANCE

- A. Comply with provisions of TMS 402/602, except where exceeded by requirements of Contract Documents.

1.6 PRECONSTRUCTION TESTING

- A. Testing will be conducted by an independent test agency, in accordance with provisions of Section 014000 - Quality Requirements.
- B. Prism Tests: Test masonry and mortar panels for compressive strength in accordance with ASTM C1314, and for flexural bond strength in accordance with ASTM C1072 or ASTM E518/E518M; perform tests and evaluate results as specified in individual masonry sections.
 - 1. Prepare two sets of prisms (consisting of three prisms); test one set at 7 days and the other at 28 days.
 - 2. A corresponding set of mortar and grout samples shall be taken with the prism. These results will be base line for in field testing. Testing lab shall test mortar and grout at a frequency specified.
 - 3. Concrete masonry prisms: Height-to-thickness ratio of not less than 1.33 and not more than 5.0; apply correction factor per TMS 402/602 for ratio other than 2.0.
- C. Mortar Mixes: Test mortars prebatched by weight in accordance with ASTM C780 recommendations for preconstruction testing.
 - 1. Test results will be used to establish optimum mortar proportions and establish quality control values for construction testing.

- D. Grout Mixes: Test grout batches in accordance with ASTM C1019 procedures.
 - 1. Test results will be used to establish optimum grout proportions and establish quality control values for construction testing.
- 1.7 DELIVERY, STORAGE, AND HANDLING
 - A. Maintain packaged materials clean, dry, and protected against dampness, freezing, and foreign matter.
- 1.8 FIELD CONDITIONS
 - A. Cold and Hot Weather Requirements: Comply with requirements of TMS 402/602 or applicable building code, whichever is more stringent.

PART 2 PRODUCTS

- 2.1 MORTAR AND GROUT APPLICATIONS
 - A. At Contractor's option, mortar and grout may be field-mixed from packaged dry materials, made from factory premixed dry materials with addition of water only, or ready-mixed.
 - B. Mortar Mix Designs: ASTM C270, Property Specification.
 - 1. Masonry below grade and in contact with earth: Type S.
 - 2. Engineered Masonry: Type S.
 - 3. Exterior, Loadbearing Masonry: Type S.
 - 4. Exterior, Non-loadbearing Masonry: Type S.
 - 5. Interior, Loadbearing Masonry: Type S.
 - 6. Interior, Non-loadbearing Masonry: Type N.
 - C. Grout Mix Designs:
 - 1. Bond Beams and Lintels: 3,000 psi strength at 28 days; 8-10 inches slump; provide premixed type in accordance with ASTM C 94/C 94M.
- 2.2 MATERIALS
 - A. Packaged Dry Material for Mortar for Unit Masonry: Premixed masonry cement and mason's sand; complying with ASTM C1714/C1714M and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
 - 1. Type: Type N.
 - 2. Color: Standard gray.
 - B. Portland Cement: ASTM C150/C150M.
 - 1. Type: Type I - Normal; ASTM C150/C150M.
 - 2. Color: Standard gray.
 - C. Masonry Cement: ASTM C91/C91M.
 - 1. Type: Type N; ASTM C91/C91M.
 - D. Hydrated Lime: ASTM C207, Type S.
 - E. Quicklime: ASTM C5, non-hydraulic type.
 - F. Mortar Aggregate: ASTM C144.
 - G. Grout Aggregate: ASTM C404.
 - H. Water: Clean and potable.
- 2.3 MORTAR MIXING
 - A. Thoroughly mix mortar ingredients using mechanical batch mixer, in accordance with ASTM C270 and in quantities needed for immediate use.
 - B. Maintain sand uniformly damp immediately before the mixing process.
 - C. Do not use anti-freeze compounds to lower the freezing point of mortar.
 - D. If water is lost by evaporation, re-temper only within two hours of mixing.
- 2.4 GROUT MIXING
 - A. Mix grout in accordance with ASTM C94/C94M.
 - B. Thoroughly mix grout ingredients in quantities needed for immediate use in accordance with ASTM C476 for fine and coarse grout.

PART 3 EXECUTION

3.1 PREPARATION

- A. Plug clean-out holes for grouted masonry with brick masonry units. Brace masonry to resist wet grout pressure.

3.2 INSTALLATION

- A. Install mortar and grout to requirements of section(s) in which masonry is specified.
- B. Work grout into masonry cores and cavities to eliminate voids.
- C. Do not install grout in lifts greater than 16 inches without consolidating grout by rodding.
- D. Do not displace reinforcement while placing grout.
- E. Remove excess mortar from grout spaces.

3.3 GROUTING

- A. Use either high-lift or low-lift grouting techniques, at Contractor's option, subject to other limitations of Contract Documents.
- B. Low-Lift Grouting:
 - 1. Limit height of pours to 12 inches.
 - 2. Limit height of masonry to 16 inches above each pour.
 - 3. Pour grout only after vertical reinforcing is in place; place horizontal reinforcing as grout is poured. Prevent displacement of bars as grout is poured.
 - 4. Place grout for each pour continuously and consolidate immediately; do not interrupt pours for more than 1-1/2 hours.
- C. High-Lift Grouting:
 - 1. Verify that horizontal and vertical reinforcement is in proper position and adequately secured before beginning pours.
 - 2. Hollow Masonry: Limit lifts to maximum 4 feet and pours to maximum height of 24 feet.
 - 3. Place grout for spanning elements in single, continuous pour.

3.4 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field tests, in accordance with provisions of Section 014000 - Quality Requirements.
- B. Test and evaluate mortar in accordance with ASTM C780 procedures.
- C. Test and evaluate grout in accordance with ASTM C1019 procedures.
- D. Prism Tests: Test masonry and mortar panels for compressive strength in accordance with ASTM C1314, and for flexural bond strength in accordance with ASTM C1072 or ASTM E518/E518M; perform tests and evaluate results as specified in individual masonry sections.

END OF SECTION

SECTION 040513 - MASONRY MORTARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mortar for masonry.

B. Related Sections:

1. Division 01: Administrative, procedural, and temporary work requirements.
2. Section 042129 – Terra Cotta Masonry.

1.2 SUBMITTALS

A. Submittals for Review:

1. Samples: 1/2 x 1/2 inch x 3 inch long colored mortar samples.

B. Quality Control Submittals:

1. Test reports: Indicating mortar compliance with ASTM C270.
2. Delivery tickets: If mortar is delivered to site dry and pre-blended, furnish delivery tickets indicating quantity, mortar type, and date of manufacture.

1.3 QUALITY ASSURANCE

- A. Perform Work in accordance with TMS 402/602.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver cement and lime in manufacturer's original, unopened packages or containers.
- B. Protect materials from moisture absorption and damage; reject damaged containers.
- C. Store aggregate to prevent inclusion of foreign matter.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers - Colorants:

1. Cathay Pigments. (www.cathaypigments.com)
2. Davis Colors. (www.daviscolors.com)
3. Solomon Colors. (www.solomoncolors.com)

B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. Portland Cement:

1. ASTM C150/C150M, Type I.
2. For exposed surfaces, provide cement from one source throughout project.

B. Aggregate:

1. ASTM C144, standard masonry type.
2. For exposed surfaces, provide aggregate from one source throughout project.

C. Lime: ASTM C207, Type S.

D. Colorant: Pure mineral oxide type, color to be selected from manufacturer's full color range.

E. Water: Clean and free from oils, acids, alkalis, organic matter, and other substances in amounts deleterious to mortar or metals in masonry.

2.3 MIXES

A. Mortar Mixes: To ASTM C270 using the Proportion Method.

1. Terra Cotta Masonry: Type N, color to be selected by Architect.

2.4 MIXING

A. Mix mortar in accordance with ASTM C270.

B. Jobsite Proportioning of Mortar:

1. Mix using mechanical mixer. Hand mixing not permitted.
2. Mix approximately three-quarters of required water, all of cement and lime, and one-half of aggregate for minimum of 2 minutes.
3. Add remainder of water and aggregate; mix for minimum of 3 minutes.

C. Dry Preblended Mortar:

1. Mix using continuous, self-cleaning mixer mounted at apex of silo cone.
2. Set water flow valve to provide workable consistency.

- D. Thoroughly mix ingredients in quantities needed for immediate use.
- E. Discard lumpy, caked, frozen, and hardened mixes.
- F. Mortar may be retempered by adding water as required. Use mortar within 2-1/2 hours after initial mixing at ambient temperatures below 80 degrees F and within 1-1/2 hours after initial mixing at ambient temperatures over 80 degrees F.
- G. Do not add accelerators, retarders, water repellents, antifreeze compounds, or other additives without Architect's approval.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Follow requirements specified in referenced sections.

END OF SECTION

SECTION 04 05 15 – PREPARING LIME MORTARS FOR HISTORIC MASONRY

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 guidance on preparing lime mortar for repointing and repairing designated historical limestone masonry in which the construction consists of lime mortar.
- B. Lime mortars are preferable to portland cement mortars for repointing and repairing historic masonry:
 - 1. Lime mortars are more permeable by water. Water passing through lime mortar will dissolve a small portion of the lime and then will deposit it in hairline cracks as the water evaporates.
 - 2. Lime mortars expand slightly during setting, and resists shrinkage which causes cracking.
- C. Lime mortars are more durable than generally recognized. Related Requirements:
 - 1. Section 013591 "Historic Treatment Procedures" for general historic treatment requirements.
 - 2. Section 040342 "Historic Stone Masonry Repair and Repointing" for stone masonry repair treatment requirements.

1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM), 100 Barr Drive, West Conshohocken, PA 19428, (610) 832-9585 or FAX (610) 832-9555.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Storage and Protection: Lime and cement must be protected from rainwater and ground moisture, as water vapor in the air can begin the setting process. Other materials also should be protected from contamination.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Lime: Should conform to ASTM C207, Type S, high plasticity, Hydrated Lime for Masonry Purposes.
 - 1. Lime which meets this standard will "work" well, resists drying during curing, and is sufficiently strong for the purpose of repointing and repairing.
 - 2. Lime expands as it hydrates, making high lime mortars more resistant to crack formation.
- B. Cement: Should conform to ASTM C150, Type I, White. It should not have more than 0.60% alkali nor more than 0.15% water soluble alkali. Use gray portland cement ONLY if a dark mortar is to be matched.
 - 1. Cement meeting this standard should increase the workability of the mortar, accelerate the setting time and slightly increase the strength of the mortar.
 - 2. The low alkali content will prevent efflorescence.
- C. Sand: Free of impurities and conforming to ASTM C144.
 - 1. Sand color, size, and texture should match the original as closely as possible. Provide a sample of the sand for comparison to the original, and have it approved by Architect before beginning repointing work.
 - 2. When possible, use bar sand or beach sand rather than crushed sand for the repointing mortar. Bar sand or beach sand should be washed to remove the salts before using.

- a. Crushed sand has sharp edges, which makes it more "sticky" and difficult to work into the joints.
 - b. Bar sand, on the other hand, has rounded edges and flows easily during the mortar application.
 - c. The working characteristics of mortar made with crushed sand may be improved by adding a slight amount of portland cement. The amount of cement should be determined by experimentation, but should not exceed 20% of the total lime/cement binder. 20% or less of cement has minimal effect on the hardness of the mortar. Cement content above 20% will make the mortar too hard.
- D. Clean, potable water: If the water must be transported or stored in a container, the container must not impart any chemicals to the water.
- E. Stone dust finely ground from the same stone as that to be repointed.
- F. Additives: No antifreeze compounds or other admixture shall be used. Do not use anti-freeze compounds. These compounds are designed for use with cement mortars, and their effectiveness with high lime mortars is questionable. Furthermore, the compounds contain salts which can lead to serious problems in the masonry later.
- G. Air entraining agents are not recommended. These agents are designed for use with cement rather than lime, and they result in decreased bonding of the mortar and the masonry. Air entraining is not necessary with high lime mortars because of the natural ability of these mortars to flex with temperature changes.

2.2 EQUIPMENT

- A. Surface temperature thermometer - can be either mechanical (less expensive but must be calibrated often) or digital electronic.
- B. Wooden mortar boxes
- C. Hoe
- D. Mesh screen
- E. Hawks: Plywood or steel hawk (mortar board)

2.3 LIME MORTAR MIXES

- A. Some factors to consider when mixing lime mortar include durability, color and texture, and workability.
 1. Durability: Repointing mortar should be softer than the masonry units and the original mortar to reduce stresses at the edge of the masonry and, in the case of lime mortar, to reduce shrinkage which can cause cracks in the mortar.
 - a. If the new mortar is harder than the masonry or the original mortar, it can cause serious stresses within the wall during thermal expansion and contraction, which can lead to deterioration of the masonry units rather than the mortar.
 - b. If the mortar is softer, any deterioration which occurs will take place in the mortar, which is easier to replace than the units themselves.
 2. The repointing mortar should allow the passage of water, both liquid and vapor. If the mortar does not allow water to pass freely through it, the water can become trapped inside the wall, freeze, and cause serious deterioration to the masonry.
 3. Color and texture: The repointing mortar should match the original mortar in color, texture, and physical characteristics.
 - a. Obtaining an accurate color match is best achieved by selecting an appropriate sand.
 - 1) Use sand which is similar to the original in color and gradation. Sand from more than one source may be required.
 - 2) For repointing of natural stones, use finely ground stone "dust" in the mortar to match the joints as closely as possible to the stone.
 - b. If the original mortar was tinted, or if it is impossible to obtain a color match using sand, it may be necessary to use a special mortar pigment. Caution: pigments may react with other

ingredients in the mortar to form efflorescence. They may also weather at a different rate than natural coloring and cause a color variation in the mortar.

- c. If pigments must be used, pure mineral oxides should be used because they do not fade or leach out of the mortar. Amount of pigment should not exceed 2% of the mortar mix by weight.
 - d. Many mortars used before the twentieth century have small lumps of incompletely burned or ground lime, or other impurities. To match the original appearance of the masonry, these impurities must be included in the new repointing mortar. Use identical materials, such as ground oyster shells (obtained at feed stores) or lumps of lime, to duplicate original lumps.
4. Workability: The workability or plasticity of the mortar is a direct result of the selection of materials.
- B. Mortar Mix:
1. Have the existing mortar completely analyzed to insure that the repointing mortar will not be less permeable/harder than the masonry units or the original mortar. IT IS BETTER TO HAVE MORTAR THAT IS MORE PERMEABLE THAN LESS.
 2. Measure all ingredients by cubic volume using a pre-established uniform measure, such as a small bucket, rather than a less uniform measure such as a shovel.
 3. For historic masonry set in lime mortar, use the following mortar mix:

1 part portland cement

3 parts lime

8-12 parts sand (To match existing mortar as closely as possible.)

NOTE: The exact mix required will relate to the grain size and sharpness of the sand and will vary depending on the supply.

-OR- For historic masonry set in standard mortar, use the following mortar mix (ASTM C270 Type "O") as a starting point:

1 part portland cement

2 parts lime or lime putty

6 to 9 parts sand and stone dust (To match existing mortar as closely as possible.)

-OR- For Limestone (ASTM C270 Type "N"):

1 part portland cement

1 parts lime

4-6 parts aggregate

Enough water to form a workable consistency

-OR- For Granite (ASTM C270 Type "S"):

2 parts portland cement

1 part lime

7-9 parts aggregate

Enough water to form a workable consistency

4. Mix a final "job-size" batch once the correct sand color, cement content, etc. have been determined through small tests to ensure the on-site mixing conditions will result in the same final product.

PART 3 - EXECUTION

3.1 ERECTION, INSTALLATION, APPLICATION

A. Mix Hydrated Lime:

1. Add dry bagged hydrated lime to water. Stir and hoe the mass to form a thick cream.

2. Allow to stand at least 24 hours before use.
- B. Prepare Roughage Premix (for later use):
 1. Accurately proportion the sand and lime using measuring boxes constructed to contain the exact volume of each ingredient required to make on batch.
 2. Mix sand and lime thoroughly for about ten minutes. Store in plastic-lined drums and seal until required. This compound may be stored indefinitely if. Kept sealed from air and kept from freezing.
 3. When required for use, add and mix the correct portion of gauging cement as specified and use immediately. Accurate portioning is very important.
- C. Add cements to lime and aggregate mixes immediately before the use of the mortar.
 1. 1. Perform all batching with wooden boxes or plastic pails of known volume to ensure standardization and conformity of measurement; shovel measurement of materials is not permitted.
 2. 2. Use box sizes that are sufficient for producing a batch size equal to one mixer load.
 3. 3. Mix dry ingredients thoroughly before adding any water (approximately five minutes).
- D. Add a small amount of water so that the mortar is just wet enough to hang on a trowel. Excess water will cause shrinkage and too little water will retard carbonation. Record the amount of water added so that it may be used as a guide for future batches.
- E. Mix mortars at least 10 minutes before using to improve workability and ensure thorough mixing. Automatic mixers should have rubber blades. Clean mixing boards and mixing machines thoroughly after each use to prevent hardened lumps of mortar from contaminating the next batch of mortar.
 1. Repointing mortars may sit 1-2 hours after initial mixing and then may be remixed to a workable consistency. This is done to reduce shrinkage.
 2. Test the mix by holding a trowel with mortar on it upside down and shaking it once.
 - a. If the mortar falls off without shaking, it has too much sand.
 - b. If more than one shake is required, the mortar is too sticky or "plastic" and the lime content must be decreased.
- F. Coloring Mortars:
 1. Take samples of freshly-broken mortar from the original masonry pointing. Note color of aggregate for color matching. Do not try to match the color of the binder. Use unweathered, unsoiled samples only.
 2. Prepare test patties of mortar approximating the inner color of the sample and set aside to dry for at least 72 hours. Drying time may be accelerated by placing the patty sample in an oven or over a hot-plate.
 3. Break the sample test patties and compare the inner portions to the original.
- G. Use repointing mortar within approximately 1-2 hours of final mixing. Retemper the mortar as necessary to maintain workability.

END OF SECTION 04 05 15

SECTION 040516 - MASONRY GROUTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grout for masonry.

B. Related Sections:

1. Division 01: Administrative, procedural, and temporary work requirements.
2. Section 042129 – Terra Cotta Masonry.

1.2 SUBMITTALS

A. Quality Control Submittals:

1. Test reports: Indicating grout compliance with ASTM C476.

1.3 QUALITY ASSURANCE

- A. Perform Work in accordance with TMS 402/602.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver cement and lime in manufacturer's original, unopened packages or containers.
- B. Protect materials from moisture absorption and damage; reject damaged containers.
- C. Store aggregate to prevent inclusion of foreign matter.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I.
- B. Aggregate: ASTM C404.
- C. Lime: ASTM C207, Type S.
- D. Water: Clean and free from oils, acids, alkalies, organic matter, and other substances in amounts deleterious to mortar or metals in masonry.

2.2 MIXES

- A. Grout Mix:

1. ASTM C476, coarse grout.
2. Compressive strength: Minimum 2000 psi at 28 days.
3. Slump: 8 to 11 inches.

2.3 MIXING

- A. Mix grout in accordance with ASTM C476.
- B. Thoroughly mix ingredients in quantities needed for immediate use.
- C. Mix dry ingredients mechanically until uniformly distributed; add water to achieve workable consistency.
- D. Discard lumpy, caked, frozen, and hardened mixes.
- E. Use grout within 2-1/2 hours after initial mixing at ambient temperatures below 80 degrees F and within 1-1/2 hours after initial mixing at ambient temperatures over 80 degrees F.
- F. Do not add accelerators, retarders, water repellents, antifreeze compounds, or other additives without Architect's approval.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Follow requirements specified in referenced sections.

END OF SECTION

SECTION 042129 - TERRA COTTA MASONRY

PART 1- GENERAL

1.1 SUMMARY

A. Section Includes:

1. Terra cotta masonry.

B. Related Sections:

1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 SUBMITTALS

A. Submittals for Review:

1. Shop Drawings: Include unit locations, sizes, and shapes; attachment; and relationship to adjacent construction.
2. Samples: Full size, nominal 8 x 8 x 12 inch terra cotta masonry showing color and finish.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Minimum 3 years experience in work of this Section.

B. Perform Work in accordance with TMS 402/602.

C. Mockup:

1. Provide mockups of each profile of terra cotta. Show:
 - a. Terra cotta size, profile, color, and texture.
 - b. Attachments, flashings, joints, and junctions.
 - c. Mortar color and texture.
2. Locate where directed.
3. Approved mockup may remain a part of the Work.

1.4 DELIVERY, STORAGE AND HANDLING

A. Store terra cotta units off ground; prevent contact with materials that could cause staining or damage.

1.5 MAINTENANCE

A. Furnish molds of each profile to Owner for future repairs.

PART 2- PRODUCTS

2.1 MANUFACTURERS

- A. Contract documents are based on products by D'Hanis Brick & Tile Company.
(www.dhanisbricktile.com)
- B. Other Acceptable Manufacturers:
 - 1. Superior Clay Corporation. (www.superiorclay.com)
 - 2. Boston Valley Terra Cotta. (www.bostonvalley.com)
- C. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. TCB - Terra Cotta Block:
 - 1. Source: D'Hanis Structural Clay Tile, or approved substitute.
 - 2. Description: Terra Cotta Block, Non-Load Bearing, Self Supported. meet or exceed ASTM C34 (Structural Clay Load-Bearing Wall Tile), Grade LB, ASTM C56 (Structural Clay Non-Load Bearing Tile), ASTM C212 (Structural Clay Facing Tile) Type FTS Rough/Altered Standard Class, and ASTM C652 (Hollow Brick) Type HBS Rough/Altered Class, tested in accordance with ASTM C67 and suitable for general use in masonry construction where not exposed to frost action.
 - 3. Size: Nominal 8" X 8" X 12".
 - 4. Finish: Glazed, Anti-Graffiti Coated.
- B. Mortar: Specified in Section 040513.
- C. Grout: Specified in Section 040516.

2.3 ACCESSORIES

- A. Tie Wire: Copper, ASTM B250, minimum 8 gage.
- B. Anchors: Stainless steel, ASTM A666, Type 304 or 316.

PART 3 - EXECUTION

3.1 INSTALLATION OF TERRA COTTA

- A. Install in accordance with approved manufacturer's instructions and approved Shop Drawings.
- B. Set units plumb and level.
- C. Align adjacent pieces in same plane.
- D. Bed each piece in full mortar bed.
- E. Completely fill joints, then rake out to allow for pointing.

F. Point joints with pointing mortar; tool to concave profile to match original mortar.

3.2 ADJUSTING

A. Touch up minor scratches and abrasions to match factory finish.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Concrete block.
- B. Mortar and grout.
- C. Reinforcement and anchorage.
- D. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 032000 - Concrete Reinforcing: Reinforcing steel for grouted masonry.
- B. Section 040511 - Masonry Mortaring and Grouting.

1.3 REFERENCE STANDARDS

- A. ASTM A82/A82M - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement; 2007.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
- C. ASTM A580/A580M - Standard Specification for Stainless Steel Wire; 2023.
- D. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.
- E. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire; 2019.
- F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2022.
- G. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.
- H. ASTM A706/A706M - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement; 2022.
- I. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2022a.
- J. ASTM C140/C140M - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units; 2022b.
- K. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2019a, with Editorial Revision.
- L. ASTM C476 - Standard Specification for Grout for Masonry; 2020.
- M. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry; 2020.
- N. ASTM C1019 - Standard Test Method for Sampling and Testing Grout for Masonry; 2020.
- O. ASTM C1072 - Standard Test Methods for Measurement of Masonry Flexural Bond Strength; 2019.
- P. ASTM C1314 - Standard Test Method for Compressive Strength of Masonry Prisms; 2021.
- Q. ASTM E518/E518M - Standard Test Methods for Flexural Bond Strength of Masonry; 2021.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for masonry units, fabricated wire reinforcement, and mortar and grout.

1.5 PRECONSTRUCTION TESTING

- A. Testing will be conducted by an independent test agency, in accordance with provisions of Section 014000 - Quality Requirements.
- B. Compressive Strength: Where indicated, test masonry prisms in accordance with ASTM C1314.
 - 1. Prepare two sets of prisms; test one set at 7 days and the other at 28 days.
 - 2. Concrete masonry prisms: Height-to-thickness ratio of not less than 1.33 and not more than 5.0; apply correction factor per TMS 402/602 for ratio other than 2.0.
- C. Flexural Bond Strength: Where indicated, test masonry prisms in accordance with ASTM E518/E518M, with tooled joints downward.

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- 1.6 MOCK-UP
 - A. Construct a masonry wall as a mock-up panel sized 8 feet long by 6 feet high; include mortar and accessories, structural backup, reinforcement, grout, flashings, weather barrier, and wall insulation in mock-up.
 - B. Locate where directed.
 - 1.7 DELIVERY, STORAGE, AND HANDLING
 - A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.
 - 1.8 FIELD CONDITIONS
 - A. Cold and Hot Weather Requirements: Comply with requirements of TMS 402/602 or applicable building code, whichever is more stringent.
 - B. Maintain materials and surrounding air temperature to minimum 40 degrees F prior to, during, and 48 hours after completion of masonry work.

PART 2 PRODUCTS

- 2.1 CONCRETE MASONRY UNITS
 - A. Concrete Block: Comply with referenced standards and as follows:
 - 1. Size: Standard units with nominal face dimensions of 16 by 8 inches and nominal depths as indicated on drawings for specific locations.
 - 2. Special Shapes: Provide non-standard blocks configured for corners.
- 2.2 MORTAR AND GROUT MATERIALS
 - A. Mortar and Grout: As specified in Section 040511.
- 2.3 REINFORCEMENT AND ANCHORAGE
 - A. Manufacturers:
 - 1. Blok-Lok Limited: www.blok-lok.com/#sle.
 - 2. Hohmann & Barnard, Inc (including Dur-O-Wal brand): www.h-b.com/#sle.
 - 3. WIRE-BOND: www.wirebond.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
 - B. Reinforcing Steel: Type specified in Section 032000; size as indicated on drawings; uncoated finish.
 - C. Strap Anchors: Bent steel shapes configured as required for specific situations, 1-1/4 in width, 0.105 in thick, lengths as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from masonry face, corrugated for embedment in masonry joint, hot dip galvanized to ASTM A153/A153M Class B.
 - D. Wall Ties: Corrugated formed sheet metal, 7/8 inch wide by 0.05 inch thick, hot dip galvanized to ASTM A 153/A 153M, Class B, sized to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from masonry face.
 - E. Two-Piece Wall Ties: Formed steel wire, 0.1875 inch thick, adjustable, eye and pintle type, hot dip galvanized to ASTM A 153/A 153M, Class B, sized to provide not less than 5/8 inch of mortar coverage from masonry face and to allow vertical adjustment of up to 1-1/4 in.
- 2.4 ACCESSORIES
 - A. Preformed Control Joints: Rubber material. Provide with corner and tee accessories, fused joints.
 - 1. Manufacturers:
 - a. Blok-Lok Limited: www.blok-lok.com/#sle.
 - b. Hohmann & Barnard, Inc (including Dur-O-Wal brand): www.h-b.com/#sle.
 - c. WIRE-BOND: www.wirebond.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- 2.5 MORTAR MIXES
 - A. Mortar: As specified in Section 040511.
 - B. Ready Mixed Mortar: ASTM C1142, Type RS.
 - C. Mortar for Unit Masonry: ASTM C270, using the Proportion Specification.

1. Engineered Masonry; Type S.
 2. Masonry below grade and in contact with earth; Type S.
 3. Exterior, loadbearing masonry; Type S.
 4. Interior, loadbearing masonry; Type S.
- 2.6 MORTAR MIXING
- A. Thoroughly mix mortar ingredients using mechanical batch mixer, in accordance with ASTM C270 and in quantities needed for immediate use.
 - B. Maintain sand uniformly damp immediately before the mixing process.
 - C. Do not use anti-freeze compounds to lower the freezing point of mortar.
 - D. If water is lost by evaporation, re-temper only within two hours of mixing.
- 2.7 GROUT MIXES
- A. Bond Beams and Lintels: 3,000 psi strength at 28 days; 8-10 inches slump; provide premixed type in accordance with ASTM C94/C94M.
 - B. Engineered Masonry: 3,000 psi strength at 28 days; 8-10 inches slump; provide premixed type in accordance with ASTM C94/C94M.
- 2.8 GROUT MIXING
- A. Mix grout in accordance with ASTM C94/C94M.
 - B. Thoroughly mix grout ingredients in quantities needed for immediate use in accordance with ASTM C476 for fine and coarse grout.

PART 3 EXECUTION

- 3.1 EXAMINATION
- A. Verify that field conditions are acceptable and are ready to receive masonry.
 - B. Verify that related items provided under other sections are properly sized and located.
 - C. Verify that built-in items are in proper location, and ready for roughing into masonry work.
- 3.2 PREPARATION
- A. Direct and coordinate placement of metal anchors supplied for installation under other sections.
 - B. Clean reinforcement of loose rust.
 - C. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.
 - D. For areas where high-lift grouting will be employed, provide cleanout openings as follows:
- 3.3 COURSING
- A. Establish lines, levels, and coursing indicated. Protect from displacement.
 - B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
 - C. Concrete Masonry Units:
 1. Bond: Running.
- 3.4 PLACING AND BONDING
- A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
 - B. Lay hollow masonry units with face shell bedding on head and bed joints.
 - C. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
 - D. Remove excess mortar as work progresses.
 - E. Interlock intersections and external corners.
 - F. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
 - G. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

3.5 REINFORCEMENT AND ANCHORAGE

- A. Reinforcement Bars: Secure at locations indicated and to avoid displacement during grouting. Minimum spacing between bars or to masonry surfaces shall be one bar diameter.
- B. Joint Reinforcement: Install horizontal joint reinforcement 16 inches on center.
- C. Anchors: Fasten anchors to structural framing and embed in masonry joints as masonry is laid. Unless otherwise indicated on drawings or closer spacing is indicated under specific wall type, space anchors at maximum of 36 inches horizontally and 24 inches vertically.

3.6 GROUTING

- A. Use either high-lift or low-lift grouting techniques, at Contractor's option, subject to other limitations of Contract Documents.
- B. Low-Lift Grouting:
 - 1. Limit height of pours to 12 inches.
 - 2. Limit height of masonry to 16 inches above each pour.
 - 3. Pour grout only after vertical reinforcing is in place; place horizontal reinforcing as grout is poured. Prevent displacement of bars as grout is poured.
 - 4. Place grout for each pour continuously and consolidate immediately; do not interrupt pours for more than 1-1/2 hours.
- C. High-Lift Grouting:
 - 1. Verify that horizontal and vertical reinforcement is in proper position and adequately secured before beginning pours.
 - 2. Place grout for spanning elements in single, continuous pour.

3.7 CONTROL AND EXPANSION JOINTS

- A. Do not continue horizontal joint reinforcement through control or expansion joints.
- B. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.

3.8 TOLERANCES

- A. Maximum Variation from Alignment of Columns: 1/4 inch.
- B. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.
- C. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.
- D. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
- E. Maximum Variation of Joint Thickness: 1/8 inch in 3 ft.

3.9 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 014000 - Quality Requirements.
- B. Concrete Masonry Unit Tests: Test each variety of concrete unit masonry in accordance with ASTM C140/C140M for compliance with requirements of this specification.
- C. Mortar Tests: Test each type of mortar in accordance with recommended procedures in ASTM C780, testing with same frequency as masonry samples.
- D. Test and evaluate grout in accordance with ASTM C1019 procedures.
- E. Prism Tests: Test masonry and mortar panels for compressive strength in accordance with ASTM C1314 and for flexural bond strength in accordance with ASTM C1072 or ASTM E518/E518M; perform tests and evaluate results.

3.10 CLEANING

- A. Remove excess mortar and mortar smears as work progresses.
- B. Use non-metallic tools in cleaning operations.

3.11 PROTECTION

- A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL DESCRIPTION OF THE WORK OF THIS SECTION:

- A. Work, in general, includes: Furnishing and installing Stone Veneer and Caps for walls, overlooks, weirs, anchors, and miscellaneous items as required to receive work of other Sections.

1.2 RELATED WORK OF OTHER SECTIONS:

- A. Coordinate work of this Section with work of other Sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work of other Sections, including:
 - 1. Section 033000, "Site Concrete."
 - 2. Section 040513, "Masonry Mortaring."
 - 3. Section 041550, "Preparing Lime Mortar for Historic Masonry."

1.3 QUALITY ASSURANCE:

- A. Codes and Standards: Comply with the provisions of the following codes, specifications and standards, except where more stringent requirements are shown or specified.
 - 1. ACI 531 - "Building Code Requirements for Concrete Masonry Structures".
 - 2. ACI 531R - "Commentary on Building Code Requirements for Concrete Masonry Structures".

1.4 SUBMITTALS:

- A. Samples: Submit four (4) samples of each type of masonry unit proposed for use on the project. Samples shall exhibit the range of color and texture to be expected in the completed work.
- B. Mock up Sample Panels: Prepare one, six (6') foot x six (6') foot sample panel of each type of masonry unit specified. Do not proceed with masonry work until sample panels has been approved. Two or more mockup panels maybe required doe the stone type selections and Historical requirements for this projects. Locate and protect until work of this Section has been approved or accepted. Remove when and as directed by Landscape Architect.
- C. Shop Drawings: Submit digital PDF copies of engineered cutting and setting drawings, showing stonework construction, including stone profiles and thickness, details of all lifting devices, joinery details, anchorage, sealing methods, stone finishes, location of all joints, work to be performed by other trades which adjoins, penetrates or is secured to stonework and all other pertinent information. Indicate location of each stonework unit on setting drawings with number designation corresponding to number marked on each unit. Submitted drawings shall bear engineers' seal.
- D. Approval of shop drawings by the Landscape Architect will not relieve the Contractor of any responsibilities for providing a system within the required performance requirements.

1.5 JOB CONDITIONS:

- A. Protect partially completed masonry against weather, when work is not in progress, by covering top of walls with strong, waterproof, non-staining membrane. Extend membrane at least two (2') feet down both sides of walls and anchor securely in place.
- B. Comply with the requirements of the governing code and with the "Construction and Protection Recommendations for Cold Weather Masonry Construction" of the Technical Notes on Stone and Tile Construction by the Stone Institute of America (BIA).

PART 2 - PRODUCTS

2.1 STONE UNITS:

- A. Supplier: Obtain units from a single manufacturer, of uniform texture and color.
- B. New Veneer and Cap Masonry Stone:
 - 1. APEX Stone, 6593 I-10 Frontage Rd, Sealey TX 77474 (979) 885-1400, www.apexstone.com.

2.2 MORTAR MATERIALS:

- A. Refer to Section 040513, "Masonry Mortaring."
- B. Refer to Section 041550, "Preparing Lime Mortar for Historic Masonry."

2.3 MASONRY ACCESSORIES:

- A. Continuous Wire Reinforcing and Ties: Provide welded wire units prefabricated in straight lengths of not less than ten (10') feet, with matching corner and tee units. Fabricate from cold-drawn steel wire complying with ASTM A82, with deformed continuous side rods and plain cross-rods, and a unit width of one and one-half (1 1/2") inches to two (2") inches less than thickness of wall or partition. Fabricate from mill galvanized wires for interior walls and hot-dip galvanized after fabrication (ASTM A153, Class B2). Provide units as follows:
 - 1. Dur-O-wal, Inc. "Ladur-Eye-Extra-Heavy", three-sixteenths (3/16") inch diameter ladder type wall reinforcement with three-sixteenths (3/16") inch diameter adjustable ties spaced twenty four (24") inches on center with eyes located to clear cavity wall insulation indicated.
- B. Anchoring Devices: Provide straps, bars, bolts, and rods fabricated from not less than 16 gauge sheet metal or three-eighths (3/8") inch diameter rod stock, unless otherwise indicated. All such items shall be of drip-type design where they extend across cavity areas.
 - 1. Dovetail Stone Anchor (at concrete back-up): Corrugated metal dovetail anchors not less than 12 gauge and not less than one (1") inch wide. Size so that units extend to within three-quarter (3/4") inch of masonry veneer.
 - 2. Galvanized Coating: For devices which extend into exterior wythe, fabricate from steel with hot-dip galvanized coating, ASTM A153, Class B2.
- C. Concrete Inserts:
 - 1. Installation of Concrete Inserts: See concrete Sections of the Specifications. Advise concrete installer of specific requirements for placement of inserts which are to be used for anchoring of masonry work.
- D. Miscellaneous Masonry Accessories:
 - 1. Reinforcing Steel Bars: Deformed steel, ASTM A615, Grade 60.
 - 2. Bond Breaker Strips: 15 Pound asphalt roofing felt complying with ASTM D226.
 - 3. Premolded Control Joint Strips: Solid rubber strips with a Shore A durometer hardness of 60 to 80, designed to fit standard sash block and maintain lateral stability in masonry wall, size and configuration as appropriate.
 - 4. Premolded Expansion Joint Filler: "Tex-Mastic Asphalt Expansion Joint Filler" by J&P Petroleum Products, Inc., or equal approved by Landscape Architect.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL:

- A. Thickness: Build masonry construction to the full thickness shown.
- B. Cutting: Cut masonry units with motor-driven saw designed to produce clean, sharp, unchipped edges. Cut units as required to fit adjoining work neatly. Use full units wherever possible.
- C. Wetting: Wet stone having absorption rates greater than 0.025 ounce per square inch per minute.

- D. Frozen Materials and Work: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen work. Remove and replace masonry work damaged by frost or freezing.
- E. Admixtures: Do not lower the freezing point of mortar by use of admixtures or antifreeze agents. Do not use calcium chloride in mortar or grout.
- F. Pattern Bond: Lay masonry in running bond with vertical joint in each course centered on units in courses above and below, unless otherwise detailed on drawings.
- G. Workmanship: Lay-up walls plumb and true and with courses level, accurately spaced and coordinated with other work.

3.2 LAYING MASONRY WALLS:

A. Horizontal Joint Reinforcing:

- 1. Provide continuous horizontal joint reinforcing. Fully embed longitudinal side rods in mortar for their entire length with a minimum cover of five-eighths (5/8") inch on exterior side of walls and one-half (1/2") inch at other locations. Lap reinforcement a minimum of six (6") inches at ends of units. Provide continuity at corners and wall intersections by use of prefabricated "L" and "T" sections. Cut and bend units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures and other special conditions.
- 2. Space continuous horizontal reinforcing at every other course, but not more than sixteen (16") inches on center vertically, except at parapets space continuous reinforcing at every course, but not more than eight (8") inches on center vertically.
- 3. Reinforce masonry openings greater than twelve (12") inches wide, with horizontal joint reinforcing placed in two horizontal joints immediately above the lintel and below sill. Extend reinforcing a minimum of twenty-four (24") inches beyond jambs of the opening, bridging control joints where provided.
- 4. All other reinforcement shall be continuous, except that it shall not pass through vertical masonry control joints.

B. Anchoring Masonry Work:

- 1. Anchor veneer to concrete back-up construction with corrugated galvanized steel dovetail stone anchors as specified. Keep dovetail slots free of mortar.
- 2. Space anchors at maximum sixteen (16") inches on center vertically and twenty-four (24") inches on center horizontally, or at maximum twenty-four (24") inches on center horizontally and sixteen (16") inches on center vertically, so as to have not more than two and two-thirds (2 2/3) square feet of wall surface area per anchor. Provide additional anchors within one (1') foot of openings and spaced not more than three (3') feet around perimeter.
- 3. Anchor veneers to metal studs with specified stone masonry veneer anchors embedded in masonry joints and screwed to studs. Stagger anchors in alternate courses.

C. Control Joints and Expansion Joints:

- 1. Provide vertical and horizontal control joints and expansion joints in masonry where shown. Build in related masonry accessory items as the masonry work progresses. Rake out mortar in preparation for application of sealants.
- 2. Joint Spacing: Provide control and expansion joints as shown on the Landscape Architect drawings. If location of control joints and expansion joints is not shown, place vertical joints spaced not to exceed twenty-five (25') feet on center and horizontal joints not to exceed story height. Locate control joints at points of natural weakness in the masonry work subject to Landscape Architect approval.

3.3 REPAIR, POINTING AND CLEANING:

- A. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as required. Provide new units to match adjoining units and install fresh mortar or grout, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge any voids or holds, except weep holes, and completely fill with mortar. Point-up all joints at corners, openings and adjacent work to provide a neat, uniform appearance, properly prepared for application of caulking or sealant compounds.
- C. Clean exposed stone masonry surface as recommended by BIA Technical Notes 20 "Cleaning Clay Products Masonry".
- D. Clean exposed concrete masonry units by dry brushing at the end of each days work and after final pointing to remove mortar spots and droppings.

END OF SECTION

DIVISION 05

Metals

95% Construction Documents

PART 1 – GENERAL

1.1 SUMMARY

- A. Section Includes: Cast-in and drilled in anchors for concrete.
- B. Related Sections:
 - 1. Division 3 Concrete Sections.
 - 2. Division 4 Masonry Sections.
 - 3. Division 5 Metals Sections.

1.2 SUBMITTALS

- A. General: Submit in accordance with Conditions of the Contract and Division 1 Submittal Procedures Section.
 - 1. Samples: Representative length and diameters of each type anchor shown on the Drawings.
 - 2. Quality Assurance Submittals:
 - a. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
 - 3. Manufacturer's installation instructions.
 - 4. Installer Qualifications & Procedures: Submit installer qualifications as stated in Section 1.03.B. Submit a letter of procedure stating method of drilling, the product proposed for use, the complete installation procedure, manufacturer training date, and a list of the personnel to be trained on anchor installation.
 - 5. Closeout Submittals: Submit the following:
 - a. Record Documents: Project record documents for installed materials in accordance with Division 1 Closeout Submittals Section.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Drilled-in anchors shall be installed by a [contractor] [installer] with at least three years of experience performing similar installations.
 - 2. Installer Training: Conduct a thorough training with the manufacturer or the manufacturer's representative for the [contractor] [installer] on the project. Training to consist of a review of the complete installation process for drilled-in anchors, to include but not limited to:
 - a. hole drilling procedure
 - b. hole preparation & cleaning technique
 - c. adhesive injection technique & dispenser training / maintenance
 - d. rebar dowel preparation and installation

1.4 DELIVERY, STORAGE AND HANDLING

- A. General: Comply with Division 1 Section Product Storage and Handling Requirements.
 - 1. Store anchors in accordance with manufacturer's recommendations.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Fasteners and Anchors:
 - 1. Bolts and Studs: ASTM A307; ASTM A449 where "high strength" is indicated on the Drawings.
 - 2. Carbon and Alloy Steel Nuts: ASTM A563.
 - 3. Carbon Steel Washers: ASTM F436.
 - 4. Carbon Steel Threaded Rod: ASTM A36; or ASTM A193 Grade B7; or ISO 898 Class 5.8.
 - 5. Wedge Anchors: ASTM A510; or ASTM A108.
 - 6. Stainless Steel Bolts, Hex Cap Screws, and Studs: ASTM F593.
 - 7. Stainless Steel Nuts: ASTM F594.
 - 8. Zinc Plating: ASTM B633.
 - 9. Hot-Dip Galvanizing: ASTM A153.
 - 10. Reinforcing Dowels: ASTM A615

2.2 CAST-IN-PLACE BOLTS

- A. Anchors, Bolts, Nuts, and Washers: Bolts and studs, nuts, and washers shall conform to ASTM A307, Grade A, and ASTM A449, ASTM A563, and ASTM F436, as applicable. Hot-dip galvanized bolts and studs including associated nuts and washers in accordance with ASTM A153.

2.3 DRILLED-IN ANCHORS

- A. Wedge Anchors: Wedge type, torque-controlled, with impact section to prevent thread damage complete with required nuts and washers. Provide anchors with length identification markings. Type and size as indicated on Drawings.
- Where anchor manufacturer is not indicated, subject to compliance with requirements and acceptance by the Engineer, provide the following:
 - Hilti Kwik Bolt 3.
 - Hilti Kwik Bolt TZ (carbon steel and AISI Type 304 Stainless Steel).
 - STRONG-BOLT 2 WEDGE ANCHOR (ICC-ES ESR 3037) BY SIMPSON STRONG-TIE CO., INC
 - Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel anchors manufactured from materials conforming to ISO 898 Part 1, with zinc plating equivalent to ASTM B633, Type III Fe/Zn 5 (5 μ m min.).
 - Exterior Use: As indicated on the Drawings, provide stainless steel anchors. Stainless steel anchors shall be manufactured from materials conforming to ISO 3506 Part 1 and having corrosion resistance equivalent to AISI [Type 304] [and] [Type 316] stainless steel. Stainless steel anchors shall be provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. All nuts shall conform to ISO 3506 Part 2 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.
- B. Screw Anchors: screw type. Pre-drilling of the hole requires a standard ANSI drill bit with the same diameter as the anchor and installing the anchor will be done with an impact wrench. Provide anchors with a diameter and anchor length marking on the head. Type and size as indicated on Drawings
- Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel anchors with zinc plating equivalent to DIN EN ISO 4042 (8mm min.).
 - Exterior Use: As indicated on the Drawings, provide stainless steel anchors. Stainless steel anchors shall be manufactured from materials conforming to ISO 3506 Part 1 and having corrosion resistance equivalent to AISI [Type 304] [and] [Type 316] stainless steel. Stainless steel anchors shall be provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. All nuts shall conform to ISO 3506 Part 2 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.
 - Where anchor manufacturer is not indicated, subject to compliance with requirements and acceptance by the Engineer, provide the following:
 - Hilti Kwik-HUS-EZ.
 - Hilti Kwik-HUS EZ-I.
 - Hilti Kwik-HUS.
 - TITEN HD SCREW ANCHORS BY SIMPSON STRONG-TIE CO., INC. (ICC REPORT NO. 1067)
- C. Heavy Duty Undercut Anchors: Bearing-type. Installed anchor shall have a minimum tension bearing area in the concrete, measured as the horizontal projection of the bearing surface, not less than two times the net tensile area of the anchor bolt. The installed anchor shall exhibit a form fit between the bearing elements and the undercut in the concrete. Type and size as indicated on Drawings.
- Where anchor manufacturer is not indicated, subject to compliance with requirements and acceptance by the Engineer, provide the following:
 - Hilti HDA.
 - Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel anchors manufactured from materials conforming to ISO 898 Part 1, with zinc plating equivalent to ASTM B633, Type III Fe/Zn 5 (5 μ m min.).
 - Exterior Use: As indicated on the Drawings, provide sherardized or stainless steel anchors. Sherardized anchors shall be manufactured from materials conforming to ISO 898 Part 1 and having corrosion resistance equivalent to ASTM A153 with sherardized dry diffusion zinc coating (50 μ m min.). Stainless steel anchors shall be manufactured from materials conforming to ISO 3506 Part 1 and having corrosion resistance equivalent to AISI [Type 316] stainless steel. Stainless steel anchors shall be provided with stainless steel nuts and washers of matching alloy group and

- minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. All nuts shall conform to ISO 3506 Part 2 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.
- D. Cartridge Injection Adhesive Anchors: Threaded steel rod, inserts or reinforcing dowels, complete with nuts, washers, polymer or hybrid mortar adhesive injection system, and manufacturer's installation instructions. Type and size as indicated on Drawings.
1. Where anchor manufacturer is not indicated, subject to compliance with requirements and acceptance by the Engineer, provide the following:
 - a. Threaded rods with adhesive using Hollow Drill Bit System for anchorage to concrete or masonry.
 - b. SIMPSON ACRYLIC-TIE ADHESIVE ANCHORING SYSTEM BY SIMPSON STRONG-TIE CO., INC. (ICBO REPORT NO. 5791),
 - c. SIMPSON SET EPOXY ANCHORING SYSTEM BY SIMPSON STRONG-TIE CO., INC. (ICBO REPORT NO. 5279),
 - d. HILTI HIT HY-70 (MASONRY ONLY)
 - e. HILTI HIT-RE 500
 - f. HILTI HIT-HY 200 (ICC-ES REPORT NO.: ESR.3187)
 - g. SIMPSON ET EPOXY ANCHORING SYSTEM BY SIMPSON STRONG-TIE CO., INC. (ICBO REPORT NO. 4945)
 2. Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel threaded rods conforming to ASTM A36, ASTM A 193 Type B7 or ISO 898 Class 5.8 with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1) [or carbon steel rods conforming to ASTM A510 with chemical composition of AISI 1038].
 3. Exterior Use: As indicated on the Drawings, provide stainless steel anchors. Stainless steel anchors shall be AISI [Type 304] [and] [Type 316] stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. All nuts shall conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.
 4. Reinforcing dowels shall be A615 Grade 60.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Cast-In-Place Bolts: Use templates to locate bolts accurately and securely in formwork.
1. Drilled-In Anchors:
 - a. Drill holes with rotary impact hammer drills using [carbide-tipped bits], [hollow drill bit system], [and][or] [core drills using diamond core bits]. Drill bits shall be of diameters as specified by the anchor manufacturer. Unless otherwise shown on the Drawings, all holes shall be drilled perpendicular to the concrete surface.
 - 1) Cored Holes: Where anchors are permitted to be installed in cored holes, use core bits with matched tolerances as specified by the manufacturer. Properly clean cored hole per manufacturer's instructions.
 - 2) Embedded Items: Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Exercise care in coring or drilling to avoid damaging existing reinforcing or embedded items. Notify the Engineer if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and telecommunications conduit, and gas lines.
 - 3) Base Material Strength: Unless otherwise specified, do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - b. Perform anchor installation in accordance with manufacturer instructions.

- c. Wedge Anchors, Heavy-Duty Sleeve Anchors, and Undercut Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in part to be fastened. Set anchors to manufacturer's recommended torque, using a torque wrench. Following attainment of 10% of the specified torque, 100% of the specified torque shall be reached within 7 or fewer complete turns of the nut. If the specified torque is not achieved within the required number of turns, the anchor shall be removed and replaced unless otherwise directed by the Engineer.
- d. Cartridge Injection Adhesive Anchors: Clean all holes per manufacturer instructions to remove loose material and drilling dust prior to installation of adhesive. Inject adhesive into holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive. Follow manufacturer recommendations to ensure proper mixing of adhesive components. Sufficient adhesive shall be injected in the hole to ensure that the annular gap is filled to the surface. Remove excess adhesive from the surface. Shim anchors with suitable device to center the anchor in the hole. Do not disturb or load anchors before manufacturer specified cure time has elapsed.
- e. Capsule Anchors: Perform drilling and setting operations in accordance with manufacturer instructions. Clean all holes to remove loose material and drilling dust prior to installation of adhesive. Remove water from drilled holes in such a manner as to achieve a surface dry condition. Capsule anchors shall be installed with equipment conforming to manufacturer recommendations. Do not disturb or load anchors before manufacturer specified cure time has elapsed.
- f. Observe manufacturer recommendations with respect to installation temperatures for cartridge injection adhesive anchors and capsule anchors.

3.2 REPAIR OF DEFECTIVE WORK

- A. Remove and replace misplaced or malfunctioning anchors. Fill empty anchor holes and patch failed anchor locations with high-strength non-shrink, nonmetallic grout. Anchors that fail to meet proof load or installation torque requirements shall be regarded as malfunctioning.

3.3 FIELD QUALITY CONTROL

- A. Testing: 10% of each type and size of drilled-in anchor shall be proof loaded by the independent testing laboratory. Adhesive anchors and capsule anchors shall not be torque tested unless otherwise directed by the Engineer. If any of the tested anchors fail to achieve the specified torque or proof load within the limits as defined on the Drawings, all anchors of the same diameter and type as the failed anchor shall be tested, unless otherwise instructed by the Engineer.
 - 1. Tension testing should be performed in accordance with ASTM E488.
 - 2. Torque shall be applied with a calibrated torque wrench.
 - 3. Proof loads shall be applied with a calibrated hydraulic ram. Displacement of adhesive and capsule anchors at proof load shall not exceed $D/10$, where D is the nominal anchor diameter.
 - 4. Minimum anchor embedments, proof loads and torques shall be as shown on the Drawings.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 052100 - Steel Joist Framing.
- B. Section 053100 - Steel Decking: Support framing for small openings in deck.
- C. Section 055000 - Metal Fabrications: Steel fabrications affecting structural steel work.

1.3 REFERENCE STANDARDS

- A. AISC (MAN) - Steel Construction Manual; 2017.
- B. AISC 303 - Code of Standard Practice for Steel Buildings and Bridges; 2016.
- C. AISC S348 - Specification for Structural Joints Using ASTM A325 or A490 Bolts; 2004.
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- E. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished; 2018.
- F. ASTM A514/A514M - Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding; 2022.
- G. ASTM A992/A992M - Standard Specification for Structural Steel Shapes; 2022.
- H. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.
- I. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2022).
- J. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel AC172; 2019.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings:
 - 1. Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners.
 - 2. Connections not detailed.
 - 3. Indicate cambers and loads.
 - 4. Indicate welded connections with AWS A2.4 welding symbols. Indicate net weld lengths.
- C. Manufacturer's Mill Certificate: Certify that products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

- A. Fabricate structural steel members in accordance with AISC (MAN) "Steel Construction Manual."
- B. Structural steel members designated as architecturally-exposed structural steel (AESS) to also comply with Section 051213.
- C. Fabricator: Company specializing in performing the work of this section with minimum 5 years of documented documented experience.
- D. Fabricator Qualifications: A qualified steel fabricator that is accredited by the AISC
 - 1. As an alternate the fabricator shall fabricate all steel under the review of a special inspector at the cost of the fabricator.

1.6 ERECTOR: COMPANY SPECIALIZING IN PERFORMING THE WORK OF THIS SECTION WITH MINIMUM 5 YEARS OF DOCUMENTED DOCUMENTED EXPERIENCE.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Steel Angles and Plates: ASTM A36/A36M.
- B. Steel W Shapes and Tees: ASTM A992/A992M.
- C. Rolled Steel Structural Shapes: ASTM A992/A992M.
- D. Steel Plate: ASTM A514/A514M.

-
- E. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- 2.2 FABRICATION
- A. Shop fabricate to greatest extent possible.
 - B. Continuously seal joined members by continuous welds. Grind exposed welds smooth.
 - C. Fabricate connections for bolt, nut, and washer connectors.
 - D. Develop required camber for members.
- 2.3 FINISH
- A. Shop prime structural steel members. Do not prime surfaces that will be fireproofed, field welded, in contact with concrete, or high strength bolted.

PART 3 EXECUTION

3.1 ERECTION

- A. Erect structural steel in compliance with AISC 303.
- B. Allow for erection loads and provide sufficient temporary bracing to maintain structure in safe condition, plumb, and in true alignment until completion of erection and installation of permanent bracing.
- C. Field weld components and shear studs indicated on shop drawings.
- D. Use carbon steel bolts only for temporary bracing during construction, unless otherwise specifically permitted on drawings. Install high-strength bolts in accordance with AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts". Bolts in connections not within the slip critical category nor subject to tension loads shall be installed in properly aligned holes and need only be tightened to the snug tight condition. The snug tight condition is defined as the tightness that exists when all plies in a joint are in firm contact. This may be attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Slip critical connections will be identified on the drawings.
- E. Do not field cut or alter structural members without approval of Architect/Structural Engineer of Record.
- F. After erection, prime welds, abrasions, and surfaces not shop primed, except surfaces to be in contact with concrete.

3.2 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch.

3.3 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 014000 - Quality Requirements.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. This Section includes requirements regarding the appearance and surface preparation of Architecturally Exposed Structural Steel (AESS).
 - 1. Refer to Division 5, Section "Structural Steel" for all other requirements regarding steelwork not included in this section.
 - 2. This section applies to any members noted on Architectural (and Structural) drawings as AESS (and in the areas defined as AESS below).

1.2 RELATED SECTIONS

- A. Section 051200 - Structural Steel Framing:
- B. Section 055000 - Metal Fabrications:
- C. Section 05300 - Metal Deck:
- D. Division 9 Section "Special Coatings" for finish coat requirements and coordination with primer and surface preparation specified in this section.
- E. Division 9 Section "Painting" for finish coat requirements and coordination with primer and surface preparation specified in this section.

1.3 SUBMITTALS

- A. General: Submit each item below according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each type of product specified.
- C. Shop Drawings detailing fabrication of AESS components.
 - 1. Provide erection drawings clearly indicating which members are considered as AESS members.
 - 2. Include details that clearly identify all of the requirements listed in sections 2.3 "Fabrication" and 3.3 "Erection" of this specification. Provide connections for exposed AESS consistent with concepts shown on the architectural or structural drawings.
 - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length and type of each weld. Identify grinding, finish and profile of welds as defined herein.
 - 4. Indicate type, size, finish and length of bolts, distinguishing between shop and field bolts. Identify high-strength bolted slip-critical, direct-tensioned shear/bearing connections. (Indicate to which direction bolt heads should be oriented.)
 - 5. Clearly, indicate which surfaces or edges are exposed and what class of surface preparation is being used.
 - 6. Indicate special tolerances and erection requirements as noted on the drawings or defined herein.
- D. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects names and address, names and addresses of architects and owners, and other information specified.
 - 1. (For each project, submit photographs showing detail of installed AESS.)

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: In addition to those qualifications listed in Division 5 Section "Structural Steel," engage a firm experienced in fabricating AESS similar to that indicated for this Project with a record of successful in-service performance, as well as sufficient production capacity to fabricate AESS without delaying the Work.
- B. Erector Qualifications: In addition to those qualifications listed in Division 5 Section "Structural Steel," engage an experienced Erector who has completed AESS work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- C. Comply with applicable provisions of the following specifications and documents:
 - 1. AISC Code of Standard Practice, latest edition, Section 10 as amended herein.
- D. Mock-ups: At least four weeks prior to fabricating AESS, the contractor shall construct mock-ups to demonstrate aesthetic effects as well as qualities of materials and execution. A mock-up for each of the following elements shall be constructed:

1. Build mock-ups to comply with the following requirements, using materials indicated for final unit of Work.
2. Locate mock-ups on-site or in the fabricator's shop as directed by Architect. Mock-ups shall be full-size pieces unless the Architect approves smaller models.
3. Notify the Architect one-week in advance of the dates and times when mock-ups will be available for review.
4. Demonstrate the proposed range of aesthetic effects regarding each element listed under the fabrication heading below.
5. Mock-up will have finished surface (including surface preparation and paint system).
6. Obtain Architect's approval of mock-ups before starting fabrication of final units.
7. Retain and maintain mock-ups during construction in an undisturbed condition as a standard for judging the completed work.
 - a. Approved mock-ups in an undisturbed condition at the time of Substantial completion may become part of the completed work.

1.5 REFERENCES

- A. SSPC-Paint 15 - Steel Joist Shop Paint; Society for Protective Coatings; 1999 (Ed. 2004).
- B. AISC (MAN) - Steel Construction Manual; American Institute of Steel Construction, Inc.; 2005.
- C. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society; 2006.
- D. ASTM A780 - Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

1.6 PRE-INSTALLATION MEETING

- A. Convene one week before starting work of this section.
- B. Pre-installation Conference: The General Contractor shall schedule and conduct conference at the project site to comply with requirements of Division 1 Section "Project Meetings." As a minimum, the meeting shall include the General Contractor, Fabricator, Erector, the finish-painting subcontractor, and the Architect. Coordinate requirements for shipping, special handling, attachment of safety cables and temporary erection bracing; touch up painting and other requirements for AESS.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver AESS to project site in such quantities and at such times to ensure continuity of installation.
- B. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration. Use special care in handling to prevent twisting or warping of AESS members.
- C. Erect pre-painted finish pieces using padded slings or other methods such that they are not damaged. Provide padding as required to protect while rigging and aligning member's frames. Weld tabs for temporary bracing and safety cabling only at points concealed from view in the completed structure or where approved by the Architect during the pre-installation meeting. Methods of removing temporary erection devices and finishing the AESS members shall be approved by the Architect prior to erection.

1.8 PROJECT CONDITIONS

- A. Field Measurements: Where AESS is indicated to fit against walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the work.

1.9 COORDINATION

- A. Coordinate installation of anchors for AESS members that connect to the work of other trades. Furnish setting drawings, templates, and directions for installing anchors, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to the project site in time for installation. (Anchorage concepts shall be as indicated on drawings and approved on final shop drawings.)

PART 2 PRODUCTS

2.1 MATERIALS

- A. General:

-
1. Meet requirements Division 5 Section "Structural Steel" as amended below.
 2. High-Strength Bolts, Nuts, and Washers: Per Section 05120 heavy hex heads and nuts (Provide rounded bolt heads with twist bolts): Provide standard carbon steel (Cadmium plated) (Mechanically galvanized) finish.
- B. PRIMERS
1. Compatibility: The General Contractor shall submit all components/procedures of the paint system for AESS as a single coordinated submittal. As a minimum, identify required surface preparation, primer, and intermediate coat (if applicable) and finish coat. All of the items shall be coordinated with the finish coat specified in Division 9.
 2. Primer: Fabricator's standard alkyd red oxide, rust inhibiting primer.
 3. Primer: Fast curing, universal modified alkyd, rust inhibiting shop coat with good resistance to normal atmospheric corrosion. Primer shall comply with all federal standards for VOC, lead and chromate levels.
 4. Primer: Acrylic water-soluble shop coat with good resistance to normal atmospheric corrosion. Primer shall comply with all federal standards for VOC, lead and chromate levels.
 5. Primer: Fast-curing two-part epoxy. Primer shall comply with all federal standards for VOC, lead and chromate levels.
 6. Primer: Organic, epoxy/zinc-rich, meeting class B surface requirements for slip-critical connections. Primer shall comply with all federal standards for VOC, lead and chromate levels.
 7. Primer: Inorganic zinc-rich meeting class B surface requirements for slip-critical connections. Primer shall comply with all federal standards for VOC, lead and chromate levels.
 8. Galvanizing Repair Paint; High-zinc-dust-content paint for galvanizing welds and repair-painting galvanized steel, with dry-film coating not less than 90-percent zinc dust by weight.
- C. FABRICATION
1. Fabricate and assemble AESS in the shop to the greatest extent possible. Locate field joints in AESS assemblies at concealed locations or as approved by the Architect. Detail AESS assemblies to minimize field handling and expedite erection.
 2. Fabricate AESS with exposed surfaces smooth, square and of surface quality consistent with the approved mock-up. Use special care in handling and shipping of AESS both before and after shop painting.
 3. In addition to special care used to handle and fabricate AESS, employ the following fabrication techniques.
 4.
 - a. Fabrication Tolerance: Fabricate steel to one half the normal tolerance as specified in the Code of Standard Practice Section 10.
 - b. Welds ground smooth: Fabricator shall grind welds of AESS smooth. For groove welds, the weld shall be made flush to the surfaces each side and be within $+1/16''$ / $-0''$ of plate thickness.
 - c. Contouring and blending of welds: Where fillet welds are indicated to be ground-contoured, or blended, oversize welds as required and grind to provide a smooth transition and to match profile on approved mock-up.
 - d. Continuous Welds: Where welding is noted on the drawings, provide continuous welds of a uniform size and profile.
 - e. Minimize Weld Show Through: At locations where welding on the far side of an exposed connection occurs, grind distortion and marking of the steel to a smooth profile with adjacent material.
 - f. Coping and Blocking Tolerance: Maintain a uniform gap of $1/8''$ & $1/32''$ at all copes and blocks.
 - g. Joint Gap Tolerance: Maintain a uniform gap of $1/8''$ & $1/32''$.
 - h. Piece Marks Hidden: Fabricate such that piece marks are fully hidden in the final structure or made with such media to permit full removal after erection.
 - i. Mill Mark Removal: Fabricator shall deliver steel with no mill marks (stenciled, stamped, raised, etc) in exposed locations. Mill marks shall be omitted by cutting of mill material to appropriate lengths where possible. Where not possible, the fabricator can fill and /or grind to a surface finish consistent with the approved mock-up.

- j. Grinding of sheared edges: Fabricator shall grind all edges of sheared, punched or flame-cut steel to match approved mock-up.
- k. Rolled Members: Member specified to be rolled to a final curved shape shall be fully shaped in the shop and tied during shipping to prevent stress relieving. Distortion of the web or stem and of outstanding flanges or legs of angles shall be visibly acceptable to the Architect from a distance of 20' under any lighting condition determined by the Architect. Tolerances for the vertical and horizontal walls of rectangular HSS members after rolling shall be the specified dimension & $\frac{1}{2}$ ".
- l. Seal weld open ends of round and rectangular hollow structural section with $\frac{3}{8}$ " closure plates. Provide continuous, sealed welds at angle to gusset-plate connections and similar locations where AESS is exposed to weather.

2.2 SHOP CONNECTIONS

- A. Bolted Connections: Make in accordance with Section 05120. Provide bolt type, finish as noted herein and align bolt heads as indicated on the approved shop erection drawings.
- B. Welded Connections: Comply with AWS D1.1 and Section 05120. Appearance and quality of welds shall be consistent with the mock-up. Assemble and weld built-up sections by methods that will maintain alignment of members without warp exceeding the tolerance of this section.

2.3 SHOP PRIMING

- A. Shop-prime steel surfaces, except the following:
 - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2".
 - 2. Surfaces to be field welded.
 - 3. Surfaces to be high-strength bolted with slip-critical connections, if primer does not meet the specified AISC slip coefficient.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust, loose mill scale, and spatter, slag, or flux deposits. Prepare surfaces according to SSPC Specifications as follows:
- C.
 - 1. SSPC-SP 1 "Solvent Cleaning"
 - 2. SSPC-SP 2 "Hand Tool Cleaning." (This level of surface preparation will not be adequate for most paint systems for AESS construction.)
 - 3. SSPC-SP 3 "Power Tool Cleansing" (This level of surface prep is the minimum for most AESS projects. It may be acceptable for alkyd primers and acrylic or alkyd finish coats, particularly in interior applications.)
 - 4. SSPC-SP 6 "Commercial Blast Cleaning." (This level of surface prep adds significantly to the total cost of the steel. It is required for epoxy primers to allow adequate bonding to the steel. Recommended for locations where a rust inhibitive primer will be used in an exterior application. It is also required where polyurethane finish coats will be used over the primer.)
 - 5. Coordinate the required blast profile with the approved paint submittal prior to beginning surface preparation.
- D. Priming: Immediately after surface preparation, apply primer according to manufacturer's instructions to provide a dry film thickness of not less than 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 - 2. Apply two coats of shop primer to surfaces that are inaccessible after assembly or erection.

2.4 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to AESS
 - 1. Indicated for galvanizing according to ASTM A 123. Fabricate such that all connections of assemblies are made in the field with bolted connections. Provide galvanized finish on members and assemblies within the range of color and surface textures presented in the mock-ups.

PART 3 EXECUTION

3.1 EXAMINATION

- A. The erector shall check all AESS members upon delivery for twist, kinks, gouges

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1. or other imperfections which might result in rejection of the appearance of the member. Coordinate remedial action with fabricator prior to erecting steel.
- 3.2 PREPARATION
- A. Provide connections for temporary shoring, bracing and supports only where noted on the approved shop drawings. Temporary connections not shown shall be made at locations not exposed to view in the final structure or as approved by the Architect. Handle, lift and align pieces using padded slings and/or other protection required to maintain the appearance of the AESS through the process of erection.
- 3.3 ERECTION
- A. Set AESS accurately in locations and to elevations indicated, and according to AISC specifications referenced in this Section.
 - B. In addition to the special care used to handle and erect AESS, employ the following erection techniques:
 1. AESS erection tolerances: Erection tolerances shall meet the requirements of standard frame tolerances for structural steel per Chapter 7 of the AISC Code of Standard Practice.
 - C. Field welding: Weld profile, quality, and finish shall be consistent with mock-ups approved prior to fabrication.
 - D. Splice members only where indicated.
 - E. Obtain permission for any torch cutting or field fabrication from the Architect. Finish sections thermally cut during erection to a surface appearance consistent with the mock up.
 - F. Do not enlarge unfair holes in members by burning or by using drift pins. Ream holes that must be enlarged to admit bolts. Replace connection plates that are misaligned where holes cannot be aligned with acceptable final appearance.
- 3.4 FIELD CONNECTIONS
- A. Bolted Connections: Install bolts of the specified type and finish in accordance with Division 5 section "Structural Steel."
 - B. Welded Connections: Comply with AWS D1.1 for procedures, and appearance. Refer to Division 5 section "Structural Steel" for other requirements.
 1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without warp. Verify that weld sizes, fabrication sequence, and equipment used for AESS will limit distortions to allowable tolerances.
 2. Obtain Architect's approval for appearance of welds in repaired or field modified work.
 3. Provide continuous all around, sealed welds at angle to gusset-plate connections, tube to tube, and similar locations where connection will allow moisture to get between members and where AESS is exposed to weather or visible to view.
- 3.5 FIELD QUALITY CONTROL
- A. Structural requirements: The Owner will engage an independent testing and inspecting agency to perform field inspections and tests and to prepare test reports. Refer to Division 5 section "Structural Steel" for detailed bolt and weld testing requirements.
 - B. AESS acceptance: The Architect shall observe the AESS steel in place and determine acceptability based on the mock-up. The Testing Agency shall have no responsibility for enforcing the requirements of this section.
- 3.6 ADJUSTING AND CLEANING
- A. Touch-up painting: Cleaning and Touch-up painting for field welds, bolted connections, and abraded areas of shop paint shall be completed to blend with the adjacent surfaces of AESS. Such touch up work shall be done in accordance with manufacturer's instructions as specified in Division 9, Section "Painting."
 - B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780.
 1. Repair Materials for Galvanized Surfaces Exposed to View: ASTM A780, zinc based solder, color matched to material being repaired.

END OF SECTION

SECTION 055213 - PIPE AND TUBE RAILINGS

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. Steel tube railings with cable pickets.
- B. Related Requirements:
 - 1. Section 043000 "Stone Veneer".
 - 2. Section 099600 "High-Performance Coatings."
 - 3. Section 321400 "Stone Paving Veneer".
 - 4. Section 323400 "Fabricated Bridges".

1.3 COORDINATION

- 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.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Manufacturer's product lines of mechanically connected railings.
 - 2. Railing brackets.
 - 3. Cable and cable infill accessories.
 - 4. Grout, anchoring cement, and paint products.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

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- C. Samples: 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.
 - D. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 - 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.8 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Cable Infill:
 - 1. Jakob 3/8 inch blackened stainless steel rope and associated hardware. Jakob, (561) 330 6502, www.jakob-usa.com
- B. Fabricator:
 - 1. Renfrow+Co, (713) 588-1768, renfrowco.com.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design railings, including attachment to building construction.
- B. 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 lbf/ ft. (0.73 kN/m) applied in any direction.
 - b. Concentrated load of 200 lbf (0.89 kN) 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 (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
 - b. Infill load and other loads need not be assumed to act concurrently.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: [120 deg F (67 deg C), ambient; 180 deg F (100 deg C, material surfaces).

2.3 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.
 - 1. Provide type of bracket with [flange tapped for concealed anchorage to threaded hanger bolt] [predrilled hole for exposed bolt anchorage] and that provides 1-1/2-inch (38-mm) clearance from inside face of handrail to finished wall surface.

2.4 STEEL AND IRON

- A. Tubing: [ASTM A 500 (cold formed)] [or] [ASTM A 513].
- B. Plates, Shapes, and Bars: ASTM A 36/A 36M.

2.5 FASTENERS

- A. General: Provide the following:
 - 1. Ungalvanized-Steel Railings: Plated steel fasteners complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5 for zinc coating.

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2. Hot-Dip Galvanized Railings: Type 304 stainless-steel or hot-dip zinc-coated steel fasteners complying with ASTM A 153/A 153M or ASTM F 2329 for zinc coating.
 3. 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.
 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.
- 2.6 MISCELLANEOUS MATERIALS
- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
1. For [aluminum] [and] [stainless-steel] 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. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Shop Primers: Provide primers that comply with Section 099600 "High-Performance Coatings."
- E. Intermediate Coats and Topcoats: Provide products that comply with Section 099600 "High-Performance Coatings."
- F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- G. 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] [and] [where indicated] 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.

2.7 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage[, but not less than that required to support structural loads].
- B. Shop assemble railings 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.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that are exposed to weather in a manner that excludes water. Provide weep holes where water may accumulate.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with [welded] [nonwelded] [either welded or nonwelded] connections unless otherwise indicated.
- H. 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.
 - 5. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
- I. Form Changes in Direction as Follows:
 - 1. As detailed.
- J. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- K. Close exposed ends of railing members with prefabricated end fittings.
- L. 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 (6 mm) or less.
- M. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

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- N. 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.

2.8 STEEL AND IRON FINISHES

- A. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with [SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."] [SSPC-SP 3, "Power Tool Cleaning."] [requirements indicated below:]
1. Exterior Railings: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 2. Railings Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 3. Railings Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 4. Other Railings: SSPC-SP 3, "Power Tool Cleaning."
- B. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
- C. Shop-Painted Finish: Comply with Section 099600 "High-Performance Coatings."
1. Color: As indicated on the drawings.
- D. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.
1. Color: As indicated on the drawings.

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. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
 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 (6 mm in 3.5 m).
- C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

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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. 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 (50 mm) beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches (150 mm) of post.

3.3 ATTACHING RAILINGS

- A. Anchor railing ends at walls with round flanges anchored to wall construction and [welded to railing ends] [or] [connected to railing ends using nonwelded connections].
- B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and [welded to railing ends] [or] [connected to railing ends using nonwelded connections].
- C. Attach railings to wall with wall brackets[, except where end flanges are used]. 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:
 1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
 2. For hollow masonry anchorage, use toggle bolts.
 3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.

3.4 ADJUSTING AND CLEANING

- A. Clean [aluminum] [and] [stainless steel] by washing thoroughly with clean water and soap and rinsing with clean water.
- B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

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

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 055213

SECTION 057500 - DECORATIVE METAL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Decorative metal panels.
2. Trim, anchorage, and accessories.

B. Related Sections: Division 01: Administrative, procedural, and temporary work requirements.

1.2 SUBMITTALS

A. Submittals for Review:

1. Shop Drawings: Show configuration of panels, trim members, and closures.
2. Product Data: Show system components including panels, trim, and accessories.
3. Samples:
 - a. 12-inch-long panel samples in selected color.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Minimum 3 years documented experience in work of this Section.

B. Mockup:

1. Size: Minimum 3 feet x 3 feet.
2. Show: Each decorative metal component; full size in color, finish, and pattern shown on Drawings, connection details, and corner detail.
3. Locate where directed.
4. Approved mockup may remain as part of the Work.

1.4 DELIVERY, STORAGE AND HANDLING

A. Protect panels from contact with materials that could cause staining or discoloration of finish.

PART 2 - PRODUCTS

2.1 MATERIALS

A. MTL-2 - Decorative Metal Panel:

1. Source: Custom Decorative Metal Panel by Zahner Company. (www.azahner.com)
2. Description: Perforated metal panel, sepia tone, powder coated.
3. Perforation Design: Custom design to be provided by Architect.
4. Provide integrated LED strip lighting. Refer to Electrical.

2.2 ACCESSORIES

- A. Fasteners: 300 Series stainless steel, type best suited to application; head color to match panels where exposed.
- B. Panel Clips: Type recommended by manufacturer.
- C. Anchoring Cement: Non-shrink cementitious type.

2.3 FABRICATION

- A. Trim: Profiles as indicated or as required, fabricated from same material as panels.
- B. Roll form panels and trim to required profiles in longest practical lengths.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved Shop Drawings.
- B. Install aligned, level, and plumb.
- C. Fasten panels to supports in concealed locations. Exposed fasteners permitted on trim members only.
- D. Locate panel joints over supports.
- E. Lap end joints 4 inches minimum.
- F. Install trim to maintain visual continuity of system.
- G. Installation Tolerances:
 - 1. Variation from location: Plus or minus 1/4 inch.
 - 2. Variation from plane: 1/4 inch in 10 feet.

3.2 ADJUSTING

- A. Touch up field cuts and abrasions on finished surfaces to match factory finish.

END OF SECTION

DIVISION 06

Wood Plastics and Composites

95% Construction Documents

SECTION 06 03 12 – HISTORIC WOOD REPAIR

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 historic treatment of wood in the form of repairing wood features as follows:
1. Repairing, replicating and replacing interior and exterior historic running and standing trim.
 2. Repairing, replicating and replacing historic wood office partition walls at corridors.
 3. Repairing and replicating historic wood ornamental features.
- B. Related Sections and Requirements:
1. Section 01 35 91 – “Historic Treatment Procedures” for general historic treatment requirements.
 2. Section 08 03 14 – “Historic Treatment of Wood Doors” for historic wood door repairs, including related trim.
 3. Section 08 03 52 – “Historic Treatment of Wood Windows” for historic wood window repairs, including related trim.
 4. Section 09 Section 09 03 91 – “Historic Treatment of Plain Painting” for general preparation for repainting of adjacent exterior surfaces.

1.3 UNIT PRICES

- A. Work of this Section is affected by unit prices specified in Section 01 2200 "Unit Prices."
1. Unit prices apply to authorized work covered by estimated quantities.
 2. Unit prices apply to authorized additions to and deletions from Work as authorized by Change Orders

1.4 PREINSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.
1. Review minutes of Preliminary Historic Treatment Conference that pertain to historic wood repair.
 2. Review methods and procedures related to historic wood repair, including, but not limited to, the following:
 - a. Historic treatment specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, material application, sequencing, tolerances, and required clearances.
 - c. Site access requirements and hours of operations.
 - d. Erection sequencing, anchoring, and safety requirements of scaffolding, lifts and hoistways, if required.
 - e. Coordination of scaffolding, lifts and hoistways access and use for all applicable rehabilitation work.
 - f. Fire-protection plan.
 - g. Wood historic treatment program
 - h. Quality-control program.
 - i. Coordination with building occupants.
 - j. Coordination with other trades working in close proximity to historic wood who may impact the work, or may be impacted by the work, including shared use of scaffolding.

- k. Review safety precautions and requirements due to unique site conditions:
 - 1) Work within and under City Public Service (CPS) utility easements.
 - 2) Potential road lane and sidewalk closures to permit erection of scaffolding.

1.5 SEQUENCING AND SCHEDULING

- A. Perform historic wood repair in the following sequence, which includes work specified in this and other Sections:
 1. Before removing wood components for on-site or off-site repair, tag each component with location-identification numbers. Indicate on tags and building plans the locations of each component, such as "Baseboard on North Side of Room 101."
 2. Dismantle hardware and tag with location-identification numbers.
 3. In the shop, label each repaired component and whole or partial replacement with permanent location-identification number in inconspicuous location and remove site-applied tags.
 4. Sort units by condition, separating those that need extensive repair.
 5. Clean surfaces.
 6. General Wood-Repair Sequence:
 - a. Remove paint to bare wood.
 - b. Repair wood by consolidation, replacement, partial replacement, and patching.
 - c. Sand, prime, fill, sand again, and prime surfaces again for refinishing.
 7. Repair, refinish, and replace hardware if required. Reinstall operating hardware.
 8. Reinstall components.
 9. Apply finish coats.
 10. Install remaining hardware.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include recommendations for product application and use. Include test data substantiating that products comply with requirements.
- B. Shop Drawings:
 1. Include plans, elevations, and sections showing locations and extent of repair and replacement work, with enlarged details of replacement parts indicating materials, profiles, joinery, reinforcing, method of splicing or attaching wood members to other surfaces, accessory items, and finishes.
 2. Include field-verified dimensions and the following:
 - a. Full-size shapes and profiles with complete dimensions for replacement components and their jointing, showing relationship of existing components to new components.
 - b. Templates and directions for installing hardware and anchorages.
 - c. Identification of each new unit and its corresponding location in the building on annotated plans and elevations.
 - d. Provisions for sealant joints, flashing, fasteners and/or hardware as required for location.
- C. Samples for Initial Selection: For each type of exposed wood and finish.
 1. Identify wood species, cut, and other features.
 2. Include Samples of hardware and accessories involving color selection.
- D. Samples for Verification: For the following products in manufacturer's standard sizes unless otherwise indicated, finished as required for use in the Work:
 1. Replacement Wood: 12-inch- (300-mm-) long, full-size molding sections with applied finish.
 2. Repaired Wood: Prepare Samples using existing wood removed from site, repaired, and prepared for refinishing.

3. Refinished Wood: Prepare Samples using existing wood removed from site, repaired, and refinished.
4. Replicated Turned Wood: Prepare Samples using replacement wood for each of the following turned wood component:
5. Full-sized Samples with applied finish representative of each profile of turned ornamental wood features to be replicated.
6. Replicated Wood Door and Window Screens: Prepare Sample of one replicated door and one replicated window, with frame and slat profiles to match previous salvaged door and window, with applied finish.
7. Hardware: Full-size units with each factory-applied or restored finish.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For historic treatment specialist including workers and wood-repair-material manufacturer (if applicable).
- B. Wood Historic Treatment Program: Submit before work begins.
- C. Preconstruction Test Reports: For historic wood repair.

1.8 QUALITY ASSURANCE

- A. Basis for Standard of Care: U.S. Department of the Interior – National Park Service – Standards and Guidelines for Historic Rehabilitation.
- B. Historic Treatment Specialist Qualifications: See Section 01 3591 - Historic Treatment Procedures for general qualifications of historic treatment specialist. A qualified historic wood-repair specialist, experienced in repairing, refinishing, and replacing wood in whole and in part. Experience only in fabricating and installing new woodwork is insufficient experience for wood historic treatment work.
 1. A list of similar jobs, completed within the last three years, shall be provided. Identify when, where, and for whom the work was performed.
- C. Wood-Repair-Material Manufacturer Qualifications: A firm regularly engaged in producing wood consolidant and wood-patching compound that have been used for similar historic wood-treatment applications with successful results, and with factory-authorized service representatives who are available for consultation, Project-site inspection, and on-site assistance.
- D. Wood Historic Treatment Program: Prepare a written, detailed description of materials, methods, equipment, and sequence of operations to be used for historic treatment work, including protection of surrounding materials and Project site.
 1. If materials and methods other than those indicated are proposed for any phase of historic treatment work, add a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project.
- E. Mockups: Prepare mockups of historic treatment repair processes to demonstrate aesthetic effects and to set quality standards for materials and execution, and for fabrication and installation. Prepare mockups so they are as inconspicuous as practicable.
 1. Locate mockups on existing surfaces where directed by Architect.
 2. Wood Repair Mockup: Prepare an approximately 24-inch (600-mm) length of to serve as mockup to demonstrate samples of each type of wood repair.
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified historic treatment specialist to perform preconstruction testing on historic wood materials as follows:

1. Provide test specimens representative of proposed materials and existing construction.
2. Test historic treatment products and methods for effectiveness and compliance with specified requirements.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Pack, deliver, and store products in suitable packs, heavy-duty cartons, or wooden crates; surround with sufficient packing material to ensure that products will not be deformed, broken, or otherwise damaged.
- B. Until installed, store products inside a well-ventilated area and protect from weather, moisture, soiling, abrasion, extreme temperatures, and humidity, and where environmental conditions comply with manufacturer's requirements.

1.11 FIELD CONDITIONS

- A. Weather Limitations: Proceed with historic wood repair only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.

PART 2 - PRODUCTS

2.1 HISTORIC WOOD REPAIR, GENERAL

- A. Quality Standard: Comply with applicable requirements in Section 12, "Historic Restoration Work," and related requirements in AWI/AWMAC/WI's "Architectural Woodwork Standards" for construction, finishes, grade rules, and other requirements unless otherwise indicated.
 1. Exception: Industry practices cited in Section 12, Article 1.5, "Industry Practices," of the Architectural Woodwork Standards do not apply to the work of this Section.

2.2 WOOD-BASED COMPONENTS

- A. Wood fabricated from old growth timber is not permitted.
 1. Exception: Old growth timber is permitted if wood is obtained from documented reclaimed source(s) and otherwise complies with applicable requirements.

2.3 REPLICATED WOOD ITEMS

- A. Replicated Wood Trim and Ornamental Features: Custom-fabricated replacement wood units and components.
 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. Basis of Design:
 - 1) Hallmark Cabinetry and Millwork, 326 Melrose Place, San Antonio, Texas 78212. Contact: John Hall at 210-828-8779, or;
 - 2) Architectural Interiors, 1350 E. Southcross Blvd., San Antonio, Texas 78223. Contact: Victor Salas at 210-319-4192.
 - b. Adams Architectural Millwork Co., Subsidiary of Dubuque Sash & Door Mfg.
 - c. Allegheny Restoration & Builders Inc.
 - d. Highland Restoration, Inc.
 - e. Historic Structures.
 - f. History Wood Window Restoration.
 - g. Honeoye Falls Millwork
 - h. Olek Lejbzon & Co.

- i. Traditional Builders, Inc.
- j. Weston Millwork Company.
- k. Woodstone Company (The).
- l. Wood Window Workshop.
2. Joint Construction: Joints matching existing joints.
3. Wood Species: Match species of existing wood.
4. Wood Cut: Match cut of existing wood.
5. Wood Member and Trim Profiles: Match profiles and detail of existing.
6. Date Identification: Emboss on a concealed surface of each replaced item, in easily read characters, "MADE 2017." Manufacturer's name may also be embossed.

2.4 WOOD-REPLACEMENT MATERIALS

- A. Wood, General: Clear fine-grained lumber; kiln dried to a moisture content of 6 to 12 percent at time of fabrication; free of visible finger joints, blue stain, knots, pitch pockets, and surface checks larger than 1/32 inch (0.8 mm) deep by 2 inches (51 mm) wide.
 1. Species: Match species of each existing type of wood component or assembly unless otherwise indicated.
- B. Exterior Trim: Match existing species.
- C. Interior Trim: Match existing species.

2.5 WOOD-REPAIR MATERIALS

- A. Source Limitations: Obtain wood consolidant and wood-patching compound from single source from single manufacturer.
- B. Wood Consolidant: Ready-to-use product designed to penetrate, consolidate, and strengthen soft fibers of wood materials that have deteriorated due to weathering and decay and designed specifically to enhance the bond of wood-patching compound to existing wood.
 1. Retain "Products" Subparagraph and list of manufacturers and products below to require specific products or a comparable product from other manufacturers.
 2. Basis-of-Design Products: Subject to compliance with requirements, provide Abatron, Inc.; LiquidWood, <http://www.abatron.com>, (800) 445-1754, or comparable product by one of the following:
 - a. ConServ Epoxy LLC; Flexible Epoxy Consolidant 100.
 - b. Gougeon Brothers, Inc.; West System.
 - c. Protective Coating Company; PC-Petrifier or PC-Rot Terminator.
 - d. System Three Resins, Inc.; RotFix.
 3. Substitutions: Under provisions of Division 01.
- C. Wood-Patching Compound: Two-part, epoxy-resin, wood-patching compound; knife-grade formulation as recommended in writing by manufacturer for type of wood repair indicated, tooling time required for the detail of work, and site conditions. Compound shall be designed for filling voids in damaged wood materials that have deteriorated due to weathering and decay. Compound shall be capable of filling deep holes and spreading to featheredge.
 1. Retain "Products" Subparagraph and list of manufacturers and products below to require specific products or a comparable product from other manufacturers.
 2. Basis-of-Design Products: Subject to compliance with requirements, provide Abatron, Inc.; LiquidWood with WoodEpoxy, <http://www.abatron.com>, (800) 445-1754, or comparable product by one of the following:
 - a. Advanced Repair Technology, Inc.; Primatrate with Flex-Tec HV.
 - b. ConServ Epoxy LLC; Flexible Epoxy Consolidant 100 with Flexible Epoxy Patch 200.
 - c. Gougeon Brothers, Inc.; West System thickened with filler.

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- d. Polymeric Systems, Inc.; QuickWood.
 - e. Protective Coating Company; PC-Woody.
 - f. System Three Resins, Inc.; Sculpwood.
3. Substitutions: Under provisions of Division 01.
- D. Borate Preservative Treatment: Inorganic, borate-based solution, with disodium octaborate tetrahydrate as the primary ingredient; manufactured for preserving weathered and decayed wood from further damage caused by fungi and wood-boring insects; complying with AWPA P5; containing no boric acid.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Abatron, INC. or comparable product by one of the following:
 - a. Abatron, Inc.
 - b. Nisus Corporation.
 - c. System Three Resins, Inc.
 2. Substitutions: Under provisions of Division 01.
- E. Cleaning Materials:
1. Detergent Solution: Solution prepared by mixing 2 cups (0.5 L) of tetrasodium pyrophosphate (TSP), 1/2 cup (125 mL) of laundry detergent that contains no ammonia, 5 quarts (5 L) of 5 percent sodium hypochlorite bleach, and 15 quarts (15 L) of warm water for each 5 gal. (20 L) of solution required.
 2. Mildewcide: Commercial, proprietary mildewcide or a solution prepared by mixing 1/3 cup (80 mL) of household detergent that contains no ammonia, 1 quart (1 L) of 5 percent sodium hypochlorite bleach, and 3 quarts (3 L) of warm water.
- F. Adhesives: Wood adhesives with minimum 15- to 45-minute cure at 70 deg F (21 deg C), in gunnable and liquid formulations as recommended in writing by adhesive manufacturer for each type of repair and exposure condition.
- G. Fasteners: Use fastener metals that are noncorrosive and compatible with each material joined.
1. Match existing fasteners in material and type of fastener unless otherwise indicated.
 2. Use concealed fasteners for interconnecting wood components.
 3. Use concealed fasteners for attaching items to other work unless exposed fasteners are unavoidable or the existing fastening method.
 4. For fastening metals, use fasteners of same basic metal as fastened metal unless otherwise indicated.
 5. For exposed fasteners, use Phillips-type machine screws of head profile flush with metal surface unless otherwise indicated.
 6. Finish exposed fasteners to match finish of metal fastened unless otherwise indicated.

2.6 WOOD FINISHES

- A. Factory-Primed Wood Finishes:
1. General: To greatest extent possible, finish historic wood repair components at fabrication shop. Defer only final touchup and cleaning until after installation. Finish historic wood repair components to comply with Section 09 9100 "Painting and Staining."
 2. Finish Coats: Manufacturer's Premium Grade.
 3. Color and Gloss: Match Munsell Color as indicated in Painting Schedule in Section 09 9100 "Painting."
 4. Preparations for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing wood historic wood repair components, as applicable to each unit of work.

- a. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of wood historic wood repair components. Apply two coats to surfaces installed in contact with concrete or masonry and to all end-grain surfaces.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect adjacent materials from damage by historic wood repair.
- B. Clean wood of mildew, algae, moss, plant material, loose paint, grease, dirt, and other debris by scrubbing with bristle brush or sponge and detergent solution. Scrub mildewed areas with mildewcide. After cleaning, rinse thoroughly with fresh water. Allow to dry before repairing or painting.
- C. Condition replacement wood members and replacement units to prevailing conditions at installation areas before installing.

3.2 HISTORIC WOOD REPAIR, GENERAL

- A. Historic Treatment Appearance Standard: Completed work is to have a uniform appearance as viewed by Architect from 5 feet (1.5 m) away for interior work and from 20 feet (6 m) away for exterior work.
- B. General: In treating historic items, disturb them as minimally as possible and as follows:
 1. Stabilize and repair wood to reestablish structural integrity and weather resistance while maintaining the existing form of each item.
 2. Remove coatings and apply borate preservative treatment before repair.
 3. Remove failed coatings and corrosion and repaint.
 4. Verify that substrate surface conditions are suitable for painting.
 5. Allow other trades to repair items in place and retain as much original material as possible before repainting.
 6. Reproduce original, historic paint systems where indicated or scheduled
 7. Repair items in place where possible.
 8. Install temporary protective measures to protect wood-treatment work indicated to be completed later, or that is in the vicinity of other components of the Work yet to be performed.
 9. Refinish historic wood.
- C. Mechanical Abrasion: Where mechanical abrasion is needed for the work, use only the gentlest mechanical methods, such as scraping and natural-fiber bristle brushing, that will not abrade wood substrate, reducing clarity of detail. Do not use abrasive methods, such as sanding, wire brushing, or power tools, except as indicated as part of the historic treatment program and as approved by Architect.
- D. Heat Processes: Do not use torches, heat guns, or heat plates.
- E. Repair and Refinish Existing Shutter Hardware: Dismantle hardware; strip paint, repair, and refinish it to match finish samples; and lubricate moving parts just enough to function smoothly.
- F. Repair Wood: Match existing materials and features, retaining as much original material as possible to perform repairs.
 1. Unless otherwise indicated, repair wood by consolidating, patching, splicing, or otherwise reinforcing wood with new wood matching existing wood or with salvaged, sound, original wood.
 2. Where indicated, repair wood by limited replacement matching existing material.
- G. Replace Wood: Where indicated, duplicate and replace units with units made from salvaged, sound, original wood or with new wood matching existing wood. Use surviving prototypes to create patterns for duplicate replacements.
 1. Do not use substitute materials unless otherwise indicated.

- H. Identify removed items with numbering system corresponding to item locations, to ensure reinstallation in same location. Key items to Drawings showing location of each removed unit. Permanently label units in a location that will be concealed after reinstallation.

3.3 WOOD PATCH-TYPE REPAIR

- A. General: Patch wood that exhibits depressions, holes, or similar voids, and that has limited amounts of rotted or decayed wood.
 - 1. Verify that surfaces are sufficiently clean and free of paint residue prior to patching.
 - 2. Treat wood with wood consolidant prior to application of patching compound. Coat wood surfaces by brushing, applying multiple coats until wood is saturated and refuses to absorb more. Allow treatment to harden before filling void with patching compound.
 - 3. In areas of advanced deterioration, remove rotted or decayed wood down to sound wood.
- B. Apply borate preservative treatment to accessible surfaces either before applying wood consolidant or after removing rotted or decayed wood. Apply treatment liberally by brush to joints, edges, and ends; top, sides, and bottom. Allow treatment to dry.
- C. Apply wood-patching compound to fill depressions, nicks, cracks, and other voids created by removed or missing wood.
 - 1. Prime patch area with application of wood consolidant or manufacturer's recommended primer.
 - 2. Mix only as much patching compound as can be applied according to manufacturer's written instructions.
 - 3. Apply patching compound in layers as recommended in writing by manufacturer until the void is completely filled.
 - 4. Sand patch surface smooth and flush with adjacent wood, without voids in patch material, and matching contour of wood member.
 - 5. Clean spilled compound from adjacent materials immediately.

3.4 WOOD-REPLACEMENT REPAIR

- A. General: Replace parts of or entire wood items at locations where damage is too extensive to patch.
 - 1. Remove surface-attached items from wood surface before performing wood-replacement repairs unless otherwise indicated.
 - 2. Verify that surfaces are sufficiently clean and free of paint residue prior to repair.
 - 3. Remove broken, rotted, and decayed wood down to sound wood.
 - 4. Custom fabricate new wood to replace missing wood; either replace entire wood member or splice new wood part into existing member.
 - 5. Secure new wood using finger joints, multiple dowels, or splines with adhesive and nailing to ensure maximum structural integrity at each splice. Use only concealed fasteners. Fill nail holes and patch surface to match surrounding sound wood.
- B. Apply borate preservative treatment to accessible surfaces after replacements are made. Apply treatment liberally by brush to joints, edges, and ends; top, sides, and bottom.
- C. Repair remaining depressions, holes, or similar voids with patch-type repairs.
- D. Clean spilled materials from adjacent surfaces immediately.
- E. Reinstall items removed for repair into original locations.

3.5 FIELD QUALITY CONTROL

- A. Manufacturers Field Service: Engage wood-repair-material manufacturers' factory-authorized service representatives for consultation and Project-site inspection, and provide on-site assistance when requested by Architect.

3.6 ADJUSTMENT

- A. Adjust existing and replacement operating items, hardware, and accessories for a tight fit at contact points and for smooth operation and tight closure. Lubricate hardware and moving parts.

3.7 CLEANING AND PROTECTION

- A. Protect wood surfaces from contact with contaminating substances resulting from construction operations. Monitor wood surfaces adjacent to and below exterior concrete and masonry during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances contact wood surfaces, remove contaminants immediately.
- B. Clean exposed surfaces immediately after historic wood repair. Avoid damage to coatings and finishes. Remove excess sealants, patching materials, dirt, and other substances.

END OF SECTION 06 03 12

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Structural dimension lumber framing.
- B. Exposed timber structural framing.
- C. Rough opening framing for doors, windows, and roof openings.
- D. Sheathing.
- E. Subflooring.
- F. Miscellaneous framing and sheathing.

1.2 RELATED REQUIREMENTS

- A. Section 061500 - Wood Decking.
- B. Section 061753 - Shop-Fabricated Wood Trusses.
- C. Section 061800 - Glued-Laminated Structural Units.

1.3 REFERENCE STANDARDS

- A. ANSI A208.1 - American National Standard for Particleboard; 2022.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2022.
- D. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2017.
- E. PS 20 - American Softwood Lumber Standard; 2010.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.

2.2 DIMENSION LUMBER

- A. Grading Agency: Southern Pine Inspection Bureau, Inc. (SPIB).
- B. Sizes: Nominal sizes as indicated on drawings, S4S.
- C. Moisture Content: S-dry or MC19.
- D. Stud Framing (2 by 2 through 2 by 6):
 - 1. Species: Douglas Fir-Larch.
 - 2. Grade: No. 3 or Stud.
- E. Joist, Rafter, and Small Beam Framing (2 by 6 through 4 by 16):
 - 1. Machine stress-rated (MSR) as follows:
 - a. Fb-single (minimum extreme fiber stress in bending): 1250 psi.
 - b. E (minimum modulus of elasticity): 1,600,000 psi.
 - 2. Species: Southern Pine.

PART 3 EXECUTION

3.1 PREPARATION

- A. Coordinate installation of rough carpentry members specified in other sections.

3.2 FRAMING INSTALLATION

- A. Set structural members level, plumb, and true to line. Discard pieces with defects that would lower required strength or result in unacceptable appearance of exposed members.
- B. Make provisions for temporary construction loads, and provide temporary bracing sufficient to maintain structure in true alignment and safe condition until completion of erection and installation of permanent bracing.
- C. Install structural members full length without splices unless otherwise specifically detailed.
- D. Comply with member sizes, spacing, and configurations indicated, and fastener size and spacing indicated, but not less than required by applicable codes and AFPA Wood Frame Construction Manual.
- E. Construct double joist headers at floor and ceiling openings and under wall stud partitions that are parallel to floor joists; use metal joist hangers unless otherwise detailed.
- F. Provide bridging at joists in excess of 8 feet span as detailed. Fit solid blocking at ends of members.
- G. Frame wall openings with two or more studs at each jamb; support headers on cripple studs.

3.3 INSTALLATION OF CONSTRUCTION PANELS

- A. Subflooring: Glue and nail to framing; staples are not permitted.
- B. Roof Sheathing: Secure panels with long dimension perpendicular to framing members, with ends staggered and over firm bearing.
 - 1. Nail panels to framing; staples are not permitted.
- C. Wall Sheathing: Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using nails, screws, or staples.
 - 1. Use plywood or other acceptable structural panels at building corners, for not less than 96 inches, measured horizontally.

3.4 TOLERANCES

- A. Framing Members: 1/4 inch from true position, maximum.
- B. Surface Flatness of Floor: 1/8 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.
- C. Variation from Plane (Other than Floors): 1/4 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.

3.5 CLEANING

- A. Waste Disposal:
 - 1. Comply with applicable regulations.
 - 2. Do not burn scrap on project site.
 - 3. Do not burn scraps that have been pressure treated.
 - 4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or "waste-to-energy" facilities.
- B. Do not leave any wood, shavings, sawdust, etc. on the ground or buried in fill.
- C. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION

SECTION 06 10 50 – ROOF CARPENTRY

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- A. Uniform General Conditions, Supplementary General Conditions, Forms, applicable Specification Sections found in all other Divisions, and all Drawings apply to Work specified in this Section.

1.2 DESCRIPTION

- A. The work shall consist of the supply and installation of new wood nailers, expansion joint curbs, replacement of all roof decks in their entirety (at Electric Pumphouse #3, Pump House, Restroom Pavilions A and B).
- B. The work shall include, but not be limited to, the supply and installation of all wood nailers, equipment supports, roof protection and other required materials, labor, plant, equipment, and all other means for the installation of the new work.

1.3 REFERENCES

- A. Related Specification Sections
1. Section 07 22 00 – Roof Insulation
 2. Section 07 23 13 – Clay Tile Roofing
 3. Section 07 41 13 – Metal Roof Panels
 4. Section 07 51 10 – Roofing Warranty
 5. Section 07 52 16 – Torch Applied Modified Bitumen Roofing
 6. Section 07 56 00 – Fluid Applied Roofing
 7. Section 07 59 50 – Roof Removal Procedures
 8. Section 07 62 00 – Sheet Metal Flashing and Trim
 9. Section 15 00 10 – Plumbing Provisions
- B. References and Standards
1. APA (American Plywood Association) Product Guide
 2. AWPA (American Wood Preservers Association) – Standard 3B. International Building Code

1.4 SUBMITTALS

- A. Submit Manufacturer and Supplier letters and test reports attesting that the products proposed for use in the project meet or exceed the requirements set forth herein.
- B. Provide certification of preservative treatment.
- C. Provide Manufacturer product data for all fasteners and steel connection devices.

1.5 QUALITY ASSURANCE AND QUALIFICATIONS

- A. Product Manufacturer, Suppliers and Installer shall be firms with no less than ten (10) years documented experience in roofing carpentry work.
- B. All lumber delivered to the project site shall be factory marked with the species, preservative type, lumber grade, exposure, and other identifying markers recommended/required by the Southern Forest Products Association.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Materials shall be delivered to the site in bulk and as necessary to allow work to proceed without delay or interruption. Schedule and coordinate all necessary deliveries to limit inconvenience or interruption of the Work of others and/or the Owner's continuing use of the site. All deliveries and unloading of materials shall be the sole responsibility of the Contractor. The Owner's representatives

and Architect shall not be responsible or requested to assist in receipt of materials. Materials shall be stored in areas designated for storage at the site.

- B. Store all materials in a dry location that precludes moisture contamination. Keep materials dry at all times by covering with polyethylene or tarps. Materials shall be stacked no higher than 48" and be bundled or retained to avoid falling. Materials may not be stocked on the roof except in quantities sufficient for one day of work. Provide blocking between stacks to ensure drying.

1.7 JOB CONDITIONS

- A. The Contractor shall be aware that portions of the building may be occupied during the work and take precautions for protection of those occupants and or persons on the ground.
- B. Precautions in the form of temporary membrane and plywood protection board shall be provided over the existing roof membrane in the areas of work to protect against puncture, damage and mortar droppings on the roof surface, etc. Temporary coverings shall be removed as soon as possible following completion of the work. Any damage to the existing and/or new roof membrane shall be repaired as soon as possible.

1.8 WARRANTY

- A. The Contractor shall guarantee all work under this Section for a period of not less than two (2) years from the date of substantial completion.
- B. The warranty shall cover all defects in material and labor and/or other failure of the work to perform as intended.

PART 2 - PRODUCTS

2.1 LUMBER

- A. Blocking shall be No. 1 grade Southern Yellow Pine or Douglas Fir.
- B. Lumber shall be Southern Yellow Pine, Douglas fir, or prior approved equal.
- C. Plywood shall be CDX grade in thicknesses shown on the Drawings. Plywood shall not be required to be treated. APA rated plywood ¾ inch minimum thick wood decking rated for structural use as roof sheathing required for clay tile roofing.
- D. Lumber shall be copper chromate treated for AWWPA 3B exposure or Borate treated.
- E. All lumber shall be dressed four sides and be minimum No. 1 grade.
- F. Lumber shall be seasoned with maximum 19% moisture content at time of dressing.
- G. Lumber meeting the above standards shall be used for all rough framing, nailers, blocking and curb extensions.
- H. Plywood used for roof protection and other disposable purposes may be utilitarian grade of the Contractor's choice.

2.2 FASTENERS AND MISCELLANEOUS MATERIALS

- A. All fasteners 0.25" and less diameter, and passing throughout or anchored in treated lumber, shall be Type 304 stainless steel. Fasteners larger than 0.25" diameter and greater shall be hot-dipped galvanized (G90 minimum) steel.
- B. To the greatest extent possible lumber shall be connected with a minimum of #12 stainless steel screws of required length. Penetration of fasteners into substrate lumber shall be minimum 1.5" depth.
- C. Fasteners for roof decking and wall sheathing #12 x required length hot-dipped galvanized or stainless steel screws.
- D. Treated lumber shall be isolated from structural steel, existing metal deck, and any other sheet metal components by one ply of standard utility-grade duct tape.

PART 3 - EXECUTION

3.1 LUMBER INSTALLATION

- A. Temporarily protect existing and new roof membrane from damage by this work.
- B. Inspect existing conditions and make arrangements for correction of deficiencies prior to beginning work.
- C. Inspect all lumber and discard any units that are split, broken, cracked, splintered or otherwise unacceptable.
- D. Utilize the longest pieces possible to minimize joints. At perimeter conditions joints shall occur no closer than 48" from an inside or outside corner. Lumber used at curb extensions shall be continuous lengths from corner to corner. Ends and corners shall be cut true and square and be tightly fitted.
- E. Pre-drill units if necessary. Replace any lumber that splits during installation.
- F. The expansion crack between panels shall be at least 1/16 inch but no greater than 1/8 inch. H-clips are to be used when rafters are spaced greater than 16 inches on center, to hold the side joints of the plywood together between supports. Unsupported end joints must be blocked.
- G. Fasteners shall penetrate a minimum of 1.5" into the solid substrate.

3.2 PROTECTION

- A. Provide 3/4" plywood sheets adhered to minimum 1" thick extruded polystyrene shall be employed for roof protection. Weight protection boards to ensure they remain secured in place during high winds.
- B. Collect and remove loose fasteners, metal pieces and other debris from the roof and ground surfaces several times daily and do not permit to remain on the finished roof surfaces. Caution shall be taken to ensure no metal debris or fasteners are left on the metal roof surfaces which may slide off the building.

END OF SECTION 06 10 50

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Plywood structural wood decking.

1.2 RELATED REQUIREMENTS

- A. Section 061000 - Rough Carpentry: Bearing support.

1.3 REFERENCE STANDARDS

- A. AITC 109 - Standard for Preservative Treatment of Structural Glued Laminated Timber; 2007.
- B. AITC 110 - Standard Appearance Grades for Structural Glued Laminated Timber; 2001.
- C. ANSI A208.1 - American National Standard for Particleboard; 2022.
- D. PS 1 - Structural Plywood; 2009 (Revised 2019).

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide technical data on wood preservative materials.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience and certified by AITC.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Plywood Decking:
 - 1. Boise Cascade, LLC; _____: www.bc.com/#sle.
 - 2. Georgia-Pacific Corporation; _____: www.buildgp.com/#sle.
 - 3. Weyerhaeuser Co; _____: www.weyerhaeuser.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.

2.2 WOOD MATERIALS

2.3 ACCESSORIES

- A. Fasteners and Anchors:
 - 1. Fastener Type and Finish: Hot-dipped galvanized steel for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
 - 2. Screws: Bugle head, hardened steel, power driven type, length three times thickness of decking.
 - 3. Anchors: Toggle bolt type for anchorage to hollow masonry.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that support framing is ready to receive decking.

3.2 PREPARATION

- A. Coordinate placement of bearing items.

3.3 TOLERANCES

- A. Surface Flatness of Decking Without Load: 1/4 inch in 10 feet maximum, and 1/2 inch in 30 feet maximum.

END OF SECTION

PART 2 PRODUCTS

1.1 MANUFACTURERS

- A. USG Corporation; _____: www.usg.com/#sle.

1.2 SHEATHING

- A. Structural cementitious roof sheathing panels.
1. Size: 48 by 96 inches, nominal.
 2. Thickness: 3/4 inch, nominal.
 3. Edges: Square.
 4. Span: 48 inches, maximum.
 5. Fire Resistance: Noncombustible, when tested in accordance with ASTM E136.
 6. Surface Burning Characteristics: Flame spread index of 0; smoke developed index of 0; when tested in accordance with ASTM E84.
 7. Mold Resistance: Rating of 10, when tested in accordance with ASTM D3273.
 8. Density: 75 psf in accordance with ASTM C1185.
 9. Weight: 5 psf in accordance with ASTM D1037 at thickness of 3/4 inch.
 10. pH Value: 10 when tested in accordance with ASTM D1293.
 11. Termite Resistance: 9.8 when tested in accordance with AWPA E1.
 12. Products:
 - a. USG Corporation; Structural Panel Concrete Roof Deck.
- B. Glass-mat-faced gypsum wall sheathing, comply with ASTM C1177/C1177M.
1. Thickness: 1/2 inch.
 2. Edges: Square.
 3. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 4. Products:
 - a. USG Corporation; Securock Brand UltraLight Glass-Mat Sheathing Regular.
- C. Glass-mat-faced gypsum wall sheathing with integral water-resistive and air barrier, comply with ASTM C1177/C1177M.
1. Size: 48 by 96 inches, nominal.
 2. Thickness: 1/2 inch.
 3. Edges: Square.
 4. Water Vapor Permeance: 1 perm, minimum, when tested in accordance with ASTM E96/E96M.
 5. Air Permeance, Sheathing: 0.001 cfm/sq ft, maximum, when tested in accordance with ASTM E2178.
 6. Air Permeance, Assembly: 0.04 cfm/sq ft, maximum, when tested in accordance with ASTM E2357.
 7. Products:
 - a. USG Corporation; Securock ExoAir 430 Panel.

1.3 SUBFLOORING

- A. Structural cementitious subfloor panels.
1. Size: 48 by 96 inches, nominal.
 2. Thickness: 3/4 inch, nominal.
 3. Edges: Squared along width; tongue and grooved along length.
 4. Span: 24 inches, maximum.
 5. Fire Resistance: Noncombustible, when tested in accordance with ASTM E136.
 6. Surface Burning Characteristics: Flame spread index of 0; smoke developed index of 0; when tested in accordance with ASTM E84.
 7. Mold Resistance: Rating of 10, when tested in accordance with ASTM D3273.
 8. Density: 75 psf in accordance with ASTM C1185.
 9. Weight: 5 psf in accordance with ASTM D1037 at thickness of 3/4 inch.
 10. pH Value: 10 when tested in accordance with ASTM D1293.
 11. Termite Resistance: 9.8 when tested in accordance with AWPA E1.
 12. Products:
 - a. USG Corporation; Structo-Crete Brand Structural Panels.

1.4 ACCESSORIES
END OF SECTION

SECTION 06 20 00 - FINISHED CARPENTRY

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. Window & transom casings, sills, aprons, casings and trim.
 - 2. Door casings and trim.
 - 3. Running base board and trim.
 - 4. Chair rails.
 - 5. Monitors, louvers and vents.
 - 6. Decorative Moldings, Fasciae, Tongue and Groove Planking, Soffits, Brackets, Supports, Window and Louver/Vent Screens.

- B. Related Requirements:
 - 1. Section 06 10 00 - Rough Carpentry: support framing, grounds, and concealed blocking.
 - 2. Section 07 62 00 - Sheet Metal Flashing and Trim.
 - 3. Section 07 92 00 - Joint Sealers.
 - 4. Section 09 03 91 – Historic Treatment of Plain Painting.

1.3 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; current edition.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2013a.
- C. AWI (QCP) - Quality Certification Program, www.awiqcp.org; current edition at www.awiqcp.org.
- D. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards; 2009.
- E. NHLA G-101 - Rules for the Measurement & Inspection of Hardwood & Cypress; National Hardwood Lumber Association; 2007.
- F. PS 1 - Structural Plywood; 2007.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Provide data on fire retardant treatment materials and application instructions.
- C. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
 - 1. Minimum Scale of Detail Drawings: 1-1/2 inch to 1 foot (1:8).

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience in restoration of historical windows.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect work from moisture damage.

PART 2 - PRODUCTS

2.1 FINISH CARPENTRY ITEMS

- A. Quality Grade: Unless otherwise indicated provide products of quality specified by AWI/AWMAC/WI Architectural Woodwork Standards for Premium Grade.
- B. Surface Burning Characteristics: Provide materials having fire and smoke properties as required by applicable code.
- C. Exterior Woodwork Items:
 - 1. Window and transoms, casings, sills, aprons, and trim: Match existing; prepare for paint finish. 15 growth rings per inch minimum.
 - 2. Door casings and running trim: Match existing; prepare for paint finish. 15 growth rings per inch minimum.
 - 3. Monitor vents: Cypress; prepare for paint finish. 15 growth rings per inch minimum.
 - 4. Decorative moldings, fasciae, soffits, brackets, supports, monitors, windows, and louver/vent screens: Match existing. Match existing; prepare for paint finish. 15 growth rings per inch minimum.
- D. Interior Woodwork Items:
 - 1. Window Sills, Aprons, Casings and Trim: Match existing; prepare for primer-only finish at locations indicated on drawings unless specifically noted otherwise on Drawings.
 - 2. Door Casings and Trim: Match existing; prepare for primer-only finish at locations indicated on drawings unless specifically noted otherwise on Drawings.

3. Running base board and trim, chair rails, monitors, louvers vents, brackets, supports, and screens. Match existing. Match existing; prepare for paint finish. 15 growth rings per inch minimum.

2.2 WOOD-BASED COMPONENTS

- A. Wood fabricated from old growth timber is not permitted.

2.3 LUMBER MATERIALS

- A. For matching existing adjacent hardwood or softwood lumber: Match existing species, match sawn, maximum moisture content of 6 percent; with vertical grain using AWI requirements for quality of wood for opaque finish. See drawings for locations of finishes.
- B. For new softwood lumber:
 1. Species: southern yellow pine "C" grade, plain sawn
 2. Moisture content: Dry to 10 percent after treatment with ACQ.
 3. Basis-of-Design Manufacturer: Alamo Hardwoods, J.R. 210-736-3137

2.4 SHEET MATERIALS

- A. A. Southern Pine face species, plain cut, unfinished, sanded.
 1. Thickness: Comparable intent in size and pattern to existing.
 2. Pattern: Match existing.
- B. Softwood Plywood Not Exposed to View: Any face species, veneer core; PS 1 Grade A-B; glue type as recommended for application.

2.5 FASTENINGS

- A. Adhesive for Purposes Other Than Laminate Installation: Suitable for the purpose; not containing formaldehyde or other volatile organic compounds.
- B. Fasteners: Of size and type to suit application; zinc plated finish in concealed locations and zinc plated finish in exposed locations.
- C. Concealed Joint Fasteners: Threaded steel.

2.6 ACCESSORIES

- A. Lumber for Shimming and Blocking: Softwood lumber of any suitable species.
- B. Primer: Alkyd primer sealer.
- C. Wood Filler: Solvent base, tinted to match surface finish color.

2.7 FABRICATION

- A. Shop assemble work for delivery to site, permitting passage through building openings.
- B. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.

2.8 SHOP FINISHING

- A. Sand work smooth and set exposed nails and screws.
- B. Apply wood filler in exposed nail and screw indentations.
- C. On items to receive transparent finishes, use wood filler that matches surrounding surfaces and is of type recommended for the applicable finish.
- D. Prime paint surfaces in contact with cementitious materials.
- E. Back prime woodwork items to be field finished, prior to installation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify adequacy of backing and support framing.

3.2 INSTALLATION

- A. Install work in accordance with AWI/AWMAC/WI Architectural Woodwork Standards requirements for grade indicated.
- B. Set and secure materials and components in place, plumb and level.
- C. Carefully scribe work abutting other components, with maximum gaps of 1/32 inch (1 mm). Do not use additional overlay trim to conceal larger gaps.

3.3 SITE APPLIED WOOD TREATMENT

- A. Apply preservative treatment in accordance with manufacturer's instructions.
- B. Brush apply one coats of preservative treatment on wood in contact with cementitious materials. Treat site-sawn cuts.
- C. Allow preservative to dry prior to erecting members.

3.4 PREPARATION FOR SITE FINISHING

- A. Set exposed fasteners. Apply wood filler in exposed fastener indentations. Sand work smooth.
- B. Site Finishing: See Section 09 9000.
- C. Before installation, prime paint surfaces of items or assemblies to be in contact with cementitious materials.

3.5 TOLERANCES

- A. Maximum Variation from True Position: 1/16 inch (1.5 mm).
- B. Maximum Offset from True Alignment with Abutting Materials: 1/32 inch (0.7 mm).

END OF SECTION 06 20 00

DIVISION 07

Thermal and Moisture Protection

95% Construction Documents

SECTION 0071700 – BENTONITE WATERPROOFING

PART 1 – GENERAL

1.1 SUMMARY

- A. This section includes bentonite-based waterproofing membrane systems for below-grade structures. Accessories including protection boards, sealants, and termination bars.

1.2 RELATED DOCUMENTS

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

1.3 REFERENCES

- A. ASTM Standards
 - ASTM D5890 – Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
 - ASTM D5887 – Hydraulic Conductivity of Bentonite
 - ASTM D6102 – Guide for Installation of Bentonite-Based Waterproofing
- B. AASHTO Standards
- C. Local and state regulations

1.4 SUBMITTALS

- A. Product Data: Manufacturer’s technical data sheets, installation instructions, and MSDS.
- B. Shop Drawings: Indicate locations, termination details, and penetrations.
- C. Samples: Minimum 12” x 12” sample of bentonite waterproofing membrane.
- D. Warranty: Manufacturer’s standard warranty for waterproofing system.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Minimum 5 years of experience producing bentonite waterproofing systems.
- B. Installer Qualifications: Certified by manufacturer with minimum 3 years of experience.
- C. Mock-Up: Provide a 4’ x 4’ mock-up for review and approval.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials in original packaging, protected from moisture and physical damage.
- B. Do not store directly on the ground or expose to prolonged sunlight.

1.7 PROJECT CONDITIONS

- A. Do not install waterproofing during rain or when ambient temperature is below 40°F (4°C).
- B. Protect installed membrane from damage during backfilling.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. CETCO Volclay
- B. W.R. Meadows CLAY-TITE
- C. Pipe Approved equal

2.2 MATERIALS

- A. Bentonite Waterproofing Membrane
 - Composite sheet consisting of sodium bentonite clay sandwiched between geotextiles.
 - Swell capacity: Minimum 24 mL/2g per ASTM D5890.
 - Hydraulic conductivity: $\leq 1 \times 10^{-9}$ cm/sec per ASTM D5887.

- B. Accessories
 - Termination bars, mastic sealant, protection boards, and fasteners as recommended by manufacturer.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Verify substrate is clean, dry, and free of sharp projections.
- B. Notify Engineer of any conditions that may adversely affect installation.

3.2 INSTALLATION

- A. Overlap seams a minimum of 4 inches and stagger joints.
- B. Install in accordance with manufacturer's instructions and ASTM D6102.
- C. Secure with fasteners or adhesive as required.
- D. Protect membrane with protection board before backfilling.

3.3 FIELD QUALITY CONTROL

- A. Inspect for proper overlap, securement, and integrity.
- B. Repair damaged areas with new membrane extending 6 inches beyond damage.

3.4 PROTECTION

- A. Do not expose membrane to UV for more than 30 days.
- B. Protect from construction traffic and debris.

3.5 CLEANING

- A. Remove excess materials and debris from site.
- B. Dispose of waste in accordance with local regulations.

END OF SECTION

SECTION 07 22 00 – ROOF INSULATION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- A. Uniform General Conditions, Supplementary General Conditions, Forms, applicable Specification Sections found in all other Divisions, and all Drawings apply to Work specified in this Section.

1.2 DESCRIPTION

- A. Work of this Section consists of the supply and installation of new roof insulation at membrane roofing installation at Electric Pump House #3. Roof insulation shall consist of the following unless noted otherwise. All insulation board layers shall set in a continuous layer of low rise foam adhesive.

- First (base) Layer: 2.2" polyisocyanurate insulation board
- Second Layer: 2.2" polyisocyanurate insulation board
- Third Layer: 1/8" per foot slope tapered insulation in configurations shown on the Drawings
- Fourth (top) Layer: 0.25" glass-faced gypsum roof board

- B. The Contractor at its option may utilize one (1) layer of 2.5" polyisocyanurate insulation board and one (1) layer of 2.0" polyisocyanurate insulation board in lieu of the two (2) layers of 2.2" board noted above.

1.3 REFERENCES

A. Related Specification Sections

1. Section 06 10 50 – Roofing Carpentry
2. Section 06 15 00 – Wood Decking
3. Section 07 51 00 – Roofing Warranty
4. Section 07 52 16 – Torch Applied Modified Bitumen Roofing
5. Section 07 56 00 – Fluid Applied Roofing
6. Section 07 59 50 – Roof Removal Procedures

B. References and Standards

1. Energy Star Rating System
2. 2015 International Energy Conservation Code
3. ASHRAE Standard 09.1 – 2015.
4. UL – "Underwriters Laboratory Roofing Materials and Systems Directory" for Class A construction over existing metal or other non-combustible roofing.
5. ASCE-7 – Requirements for Wind Uplift Rating
6. National Roofing Contractors Association (NRCA) "Roofing and Waterproofing Manual" – applicable sections
7. ASTM C-1289-06, Type II, Class I, Grade 3 – Standard Specification for Faced Rigid Cellular Polyisocyanurate Insulation Board – 25psi
8. ASTM C-1177 – glass-faced gypsum roof board
9. ASTM E-108 – Standard Test Methods for Fire Test of Roof Coverings
10. ASTM E-119 – Standard Test Methods for Fire Tests of Building Construction and Materials.
11. ASTM E-2114-01 – Standard Terminology for Sustainability Relative to the Performance of Buildings
12. ASTM E-2129-01 – Standard Practice for Data Collection for Sustainability Assessment of Building Products

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13. FM 4470 – Approval Standard – Roof I Roof Covers
 14. LTTR – Long Term Thermal Resistance predicted by CAN/ULC-5770-03.
 15. UL 263 – Fire Tests of Building Construction and Materials
 16. UL 790 – Standard Test Methods for Fire Test of Roof Coverings

1.4 SUBMITTALS

- A. Submit product data for all materials proposed for installation under this Section, including but not limited to insulation products, adhesives and fasteners.
- B. Provide Manufacturer's written installation procedures and standard details for installation of insulation and low-rise foam adhesive.
- C. Submit material safety data sheets (MSDS) for all products.

1.5 QUALITY ASSURANCE AND QUALIFICATIONS

- A. Each Manufacturer of products specified in this Section shall be companies specializing in the manufacture of products under this Section with a minimum ten (10) years of documented experience and a minimum of ten (10) completed projects within the State of Texas of the same type and similar size to this project.
- B. The installer shall be experienced in the application of this same or similar system and provide evidence of the successful completion of a minimum of five (5) projects completed within the State of Texas of the same type and minimum 20,000 sf in size. The installer shall be certified in writing by the Manufacturer as being an acceptable applicator trained in the application of its system.
- C. Work of this Section shall strictly conform to each product Manufacturer's installation instructions and these Specifications. One copy of each document shall be maintained at the site at all times work is underway.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Materials shall be delivered to the site in the Manufacturer's original sealed and labeled shrouds and containers, on pallets and in quantities to allow continuity of application throughout the Work. Schedule and coordinate all necessary deliveries to limit inconvenience or interruption of the Work of others and/or the Owner's continuing use of the site. All deliveries and unloading of materials shall be the sole responsibility of the Contractor. The Owner's representatives and Architect shall not be responsible or requested to assist in receipt of materials.
- B. Non-combustible materials may be stored on the roof when properly protected from damage and the elements. All materials shall be handled in a manner to preclude damage and contamination by moisture or other foreign matter.
- C. Insulation board shall be covered during inclement weather by waterproof tarps or coverings and be secured to prevent displacement by high winds.
- D. Insulation materials may be stored on the roofs provided the roofs are protected at all times from damage. Evenly distribute materials on the roof surfaces so as to not exceed 25 pounds per square foot. Brace products which may roll or slide off the roof. Do not stack materials more than 48" high. Weight insulation board to prevent it from blowing off the roof. Any damage to the existing or new roof membrane shall be corrected at the Contractor's expense.

1.7 JOB CONDITIONS

- A. Insulation shall not be applied during precipitation. The Contractor reserves the final determination as to whether to chance roofing operations when rain threatens.
- B. The Contractor shall consider wind speed as a determinate factor as to whether roofing operations can be undertaken safely and without causing overspray damage to the building or vehicles. The Contractor shall immediately suspend work if in its opinion wind may impede the proper installation of the work or might cause damage to surrounding elements.

1.8 WARRANTY

- A. The Contractor shall provide a two (2) year warranty covering defects in insulation materials and labor on the form found in Section 07 51 00 of these Specifications.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Any polyisocyanurate insulation manufacturer whose products meet the minimum standards of these Specification is acceptable.
B. The roof membrane / polyisocyanurate roof insulation manufacturer shall be the same.

2.2 INSULATION, FASTENERS AND ADHESIVE MATERIALS

- A. Polyisocyanurate insulation board shall be maximum 48" x 48" sizes for low slope roofs. Insulation shall be provided in the thicknesses specified. Insulation shall be supplied with a minimum LTTR-value of 5.7 per 1.0" thickness. If the LTTR is less than 5.7 per 1.0" thickness the insulation thickness shall be increased to reach the minimum R-25 value required the local code.
B. Tapered polyisocyanurate insulation board shall have a minimum slope of 1/8" per foot. The board shall have a starting edge thickness of 0.25" or 0.5".
C. Crickets shall be manufactured from 1/4" per foot tapered polyisocyanurate insulation board. The board shall have a starting edge thickness of 0.25" or 0.5". Tapered perlite edges shall be provided for a smooth transition along the edges of crickets and saddles. Abrupt vertical changes will not be permitted.
D. Glass-faced gypsum roof board equal to DensDeck by Georgia-Pacific, or Securock by USG.
E. Low rise foam or other adhesive approved in writing by the membrane system manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

- A. The Contractor shall examine the existing roof, deck and conditions at the site to confirm acceptability and that the surface is ready for insulation installation. Inform the Architect in writing of any conditions which may adversely affect the intended installation.
B. Provide protection of the existing surrounding building surfaces.
C. Provide protection to prevent debris from entering gutters, roof drains, scuppers and other drainage devices, and from entering the interior of the building. Remove temporary protection from drainage devices daily.
D. Provide protection to prevent materials from falling from the building. Provide ground protection, warning signs, barricades and other devices as required to protect persons on the ground. See Section 07 59 50 – Roof Removal Procedures.
E. Wood blocking required at the perimeter and at other conditions shall be completed per Section 06 10 50 – Roofing Carpentry. Wood blocking at the roof perimeter shall match the new insulation height.

3.2 INSULATION INSTALLATION

- A. Only as much insulation may be laid at a time as can be covered entirely with the new plywood and underlayment system by the end of the work day.
B. Insulation boards on all layers shall be butted tightly against each other. All gaps shall be filled with foam adhesive or cut insulation pieces. Board joints shall be staggered 12" to 24" along opposing sides and 24" between layers.
C. Boards installed over clean structural concrete decks shall be applied with low rise foam adhesive applied in a solid application at each layer. Ribbon stripping of adhesive is unacceptable unless the wind uplift rating for such application has been substantiated by the roof system manufacturer.

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- Boards shall be walked in and weighted until the adhesive has set sufficiently that the boards may not lose bond to the lower surface(s). Boards set over irregular deck surfaces shall be scored or otherwise cut to permit full adhesion to all underlying surfaces. All subsequent layers and tapered insulation shall be fully adhered in low rise foam adhesive.
- D. Provide 48" x 48" tapered insulation sumps around each roof drain as shown on the Drawings. Provide crickets in between the roof drains and along walls where shown on the Drawings, and where equipment curbs exceed 48" in length. Crickets shall be formed from tapered polyisocyanurate insulation and/or perlite insulation board, be set in low rise foam adhesive, and begin at 0" elevations along each edge. All tapered materials shall be covered with glass-faced gypsum roof board.
 - E. Unsecured insulation shall be removed from the site daily.

END OF SECTION 07 22 00

SECTION 07 32 -13 – CLAY TILE ROOFING

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- A. Uniform General Conditions, Supplementary General Conditions, Forms, applicable Specification Sections found in all other Divisions, and all Drawings apply to Work specified in this Section.

1.2 DESCRIPTION

- A. Work of this Section consists of inspection of salvaged roof tiles for reuse, cleaning of existing tiles, re-installation of sound historic clay tile roofing and parapets, supplemental and new clay tile roofing, underlayment, and waterproof coating where shown on the Drawings.
- B. Existing clay tile shall be carefully inspected. Loose tiles to be replaced are to be removed and stored at ground level in safe and secure storage container if reusable.
- C. The Contractor shall immediately upon issuance of the contract with the Owner order a quantity of field tile equaling existing damage and a percentage equal to the anticipated damage to occur during the tile removal procedures at Restroom Pavilion A and Electric Pump House #3 as well as the new tile for the entirety of Restroom Pavilion B and the roof surface requiring replacement from Ludowici. Ludowici shall manufacturer new custom tile matching exactly the color and shape of the existing tile or provide an in-kind match.
- D. Every precaution shall be taken to ensure rake and special shape tiles remain unbroken during tile removal. repairs and re-installation. In the event any that these tile are broken the Contractor shall replace with an in-kind match or order special replacement pieces from Ludowici.

1.3 REFERENCES

- A. Related Specification Sections
1. Section 02 42 96 - Historic Removal and Dismantling
 2. Section 06 10 50 – Roofing Carpentry
 3. Section 07 51 00 – Roofing Warranty
 4. Section 07 57 13 - Liquid Applied Roof Membrane
 5. Section 07 59 50 – Roof Removal Procedures
 6. Section 07 62 00 – Flashing and Sheet Metal
- B. References and Standards
1. National Roofing Contractors Association (NRCA) “Roofing and Waterproofing Manual” – latest edition, applicable sections.
 2. *Concrete and Clay Tile Installation Manual (CCTIM)* produced by the Tile Roofing Institute (TRI) and Western States Roofing Contractors Association – latest edition, applicable sections.
 3. Tile Manufacturer’s Installation Manual. Basis-of-Design Ludowici Shingle and Barrel Tile Installation Manuals
 4. ASTM A580 – Standard Specification for Stainless Steel Wire
 5. ASTM C270 – Standard Specification for Mortar for Unit Masonry
 6. ASTM C920 – Standard Specification for Elastomeric Joint Sealants
 7. ASTM C1167 – Standard Specification for Grade 1 Roof Tile with Water Absorption Less Than Two Percent (2%)
 8. ASTM D1970 – Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials
 9. ASTM E108 – Standard Test Methods for Fire Tests of Roof Coverings

1.4 SUBMITTALS

- A. Submit product data for all materials proposed for installation under this Section, including but not limited to each type of underlayment, tile, battens, fasteners and sealants.
- B. Copy of purchase order to be placed from supplier including ability to match the tile shape and color, and delivery date.
- C. Registered structural engineer's review and written letter of approval that weight of underlayment, fastening system, roof accessories tile roofing and exposure can be supported by the structures.

1.5 QUALITY ASSURANCE AND QUALIFICATIONS

- A. The installer shall have ten (10) years' experience and be experienced in the application of this same or similar system and provide evidence of the successful completion of a minimum of five (5) projects within the State of Texas of the same type with each being a minimum 10,000 sf roof in size.
- B. The Manufacturer of each component shall be experienced in the production of this same or similar system for a minimum of ten (10) years and able to provide evidence of the successful completion of a minimum of ten (10) projects within the State of Texas in the preceding five (5) year period.
- C. Mock-Ups shall be required for Architect approval.
 - 1. Mock-Up 1: Restroom Pavilion A, Minimum one roofing square installed at eave and hip intersection after new underlayment and decking are installed. Include underlayment, eave and hip tiles with historic and new tile blending pattern, sheet metal, grout and required fasteners.
 - 2. Mock-up 2: Restroom Pavilion A, Clerestory at monitor. Include eave and ridge tile, louver and knee wall tile. Include at least four consecutive tiles, grout and the end termination.
 - 3. Mock-up 3: Electric Pump-House #3, Parapet. Include at least four consecutive tiles, and the end termination, PMMA waterproofing under tiles, corner pilaster waterproofing, termination bar.
- D. The general contractor shall engage a registered structural engineer to evaluate the structural design of the roof to determine if it will carry the total weight of the clay tile roof system.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Materials shall be delivered to the site on pallets as applicable, and in quantities to allow continuity of application throughout the Work. Schedule and coordinate all necessary deliveries to limit inconvenience or interruption of the Work of others and/or the Owner's continuing use of the site. All deliveries and unloading of materials shall be the sole responsibility of the Contractor. The Owner's representatives and Architect shall not be responsible or requested to assist in receipt of materials.
- B. Evenly distribute materials on the roof surfaces so as to not exceed 30 pounds per square foot. No more than six (6) tile shall be in each stack.
- C. Maintain stored sealants at Manufacturer's recommended temperatures.

1.7 JOB CONDITIONS

- A. Roofing work shall not be performed without protections in place for pedestrians and right-of-way traffic to prevent falling objects due to historic building's lack of setbacks.
- B. Roofing work shall not be performed without ground-based protection structures and in place.
- C. Roofing work shall not be performed during precipitation or started in the event precipitation is anticipated while the building interior is exposed. The Contractor reserves the final determination as to whether to chance roofing operations when rain threatens.
- D. Materials shall only be applied to dry surfaces. Surfaces intended to receive the work shall be allowed to thoroughly dry before beginning work.
- E. Store roofing underlayment and limit exposure to sunlight per manufacturer's recommendations.

1.8 WARRANTY

- A. The Contractor shall provide a two (2) year warranty covering defects in materials and labor on the form in Section 07 50 10 of these Specifications.

PART 2 - PRODUCTS

2.1 CLAY TILE ROOFING

- A. Existing tiles being removed – verify shingle style at Restrooms and barrel tile style at Electric Pump House. Tile shape and color blend to match the historic tile. Refer to Section 0242 96 Historic Removal and Dismantling.
- B. Supplemental replacement tile. Additional pieces are required to replace damaged clay tile units on Restroom Pavilion A pitched roof, Electric Pump House #3 parapet, and to convert Restroom Pavilion B shingle roofing material from composition shingle to clay tile roofing.
1. Refer to Clay Tile Roofing salvage and replacement tile sample matching information in Section 02 42 96.
 2. The Contractor shall locate used or replicated tile sources for supplemental replacement and matching roofing as needed to roof Restroom Pavilions and Electric Pump House.
 3. To the Greatest extent possible supplemental and replacement tile shall match the color, size and texture of the tile currently on the roofs.
 4. The Contractor shall estimate the number of supplemental replacement tile it believes will be necessary to complete the project and include that number in the Base Bid and on the Bid Form. The Contractor shall also provide for twenty (20) supplemental tile on the Bid Form. The unit pricing will be utilized only when the estimated number of tiles is exhausted provided the Contractor is cautious and limits breakage.
 5. The Contractor shall take all precautions necessary to salvage existing tile intact as the tiles are removed from Electric Pump House #3 and Restroom Pavilion A.
 6. Chipped, cracked and broken tiles shall be discarded. The Architect will inspect chipped tile and may accept tile with minor chips.
 7. Contaminants such as mortar, sealant, and/or roofing cement shall be removed from salvaged tile to the greatest extent possible. The Architect shall determine what contaminants are acceptable and may remain. Tiles broken in the cleaning process shall be discarded.
- C. Electric Pump House #3, Parapet clay roof tiles.
1. Salvage and reuse existing intact historic tiles. Replace broken or damaged tiles with new tiles to match existing tile characteristics and pattern.
 2. Style: Barrel or Mission tiles. Profile, size, texture, finish, and two – three color(s) blend to match existing.
 3. Basis-of-Design: Historic tile installed in the field to replicate to match existing by Ludowici Roof Tile Co.
www.ludowici.com
4757 Tile Plant Rd.
P.O. Box 69
New Lexington, Ohio 43764
info@ludowici.com
(800) 945.8453
Cindy Walker, cinder.walker@ludowici.com
- D. Restroom Pavilion A, Clay roof tiles on pitched roof.
1. Salvage and reuse existing intact historic tiles. Replace broken or damaged tiles with new tiles to match existing tile characteristics.

-
2. Style: Shingle or Flat tiles. Confirm tiles are not interlocking type. Profile, size, texture, exposure, fittings and color to match existing.
 3. Basis-of-Design: Historic tile installed in the field to replicate to match existing by Ludowici Roof Tile Co.
www.ludowici.com
4757 Tile Plant Rd.
P.O. Box 69
New Lexington, Ohio 43764
info@ludowici.com
(800) 945.8453
Cindy Walker, cindy.walker@ludowici.com
- E. Restroom Pavilion B, Clay roof tiles on pitched roof.
1. Replace existing composition shingle roof with new clay tile roof. Clay roof tiles to match Restroom Pavilion A supplemental tiles.
 2. Style: Shingle or Flat tiles. Profile, size, texture, exposure, fittings, and color to match existing Pavilion A clay roof tiles.
 3. Basis-of-Design: Historic tile installed in the field to remake to match existing by Ludowici Roof Tile Co.
www.ludowici.com
4757 Tile Plant Rd.
P.O. Box 69
New Lexington, Ohio 43764
info@ludowici.com
(800) 945.8453
Cindy Walker, cindy.walker@ludowici.com
- 2.2 CLAY TILE ROOFING CLEANERS
- A. Clean rust and debris off existing roof tiles removed for reuse as recommended by supplemental clay tile roofing manufacturer.
- 2.3 UNDERLAYMENT
- A. Basis-of-Design: One layer of 40 mil Ice and Water Shield or approved self-adhering, self-sealing equal that meets or exceeds ASTM D1970, ASTM E108/UL 790 Class A Fire Resistance and factory -applied anti-skid coating.
 1. Carlisle WIP 300 HT.
 2. Grace Construction Products "Ultra"
 - B. If roof construction sequencing dictates more than 60 days of underlayment sunlight exposure, then 180 day exposure underlayment product must be provided.
- 2.4 WATERPROOF COATING
- A. At Electric Pump House #3, PMMA seamless membrane waterproofing at and over parapet wall, under the clay roof tiles, and over the termination bar as indicated in the drawings. Refer to Section 07 57 13 Liquid Applied Roof Membrane.
 - B. At Electric Pump House # 3, parging at parapet corner pilasters.
- 2.5 FASTENERS
- A. Batten Fasteners: Minimum 12d or 16d stainless steel nails. Nails shall be long enough to penetrate the battens and deck protruding at least $\frac{3}{4}$ inches below the underside of the deck.

-
- B. Tile Nails: Minimum 2.0" long x 11-gauge stainless steel ring-shank roofing nails with 3/8" diameter head. Nails are to be long enough to hold the tile and penetrate at least 3/4 inches into the battens and deck lumber section.
 - 1. Nails should not be driven tight against tile to prevent cracking or breaking of tile and allow for movement.
 - 2. Nails must not penetrate underside of exposed deck.
 - 3. Galvanized, ceramic coated or any other fastener not mentioned above is not acceptable.
 - 4. Fasten each tile with nails in every provided fastening hole.
 - C. Screws: Minimum 2.0" long x 11 gauge. Screws shall be long enough to penetrate through the underside of the wood deck by 0.75"
 - D. Sealant: Dow Corning Clear Silicone Rubber Sealant, or clear silicone sealant as manufactured by General Electric or approved equal.
 - E. Elastic Cement: Use only non-staining, non-corrosive cement as recommended by the manufacturer.

2.6 MISCELLANEOUS

- A. Battens: as required by clay roof tile manufacturer. Pressure treated nailed on underlayment.
- B. Sealant: See Section 07 62 00 – Flashing and Sheet Metal
- C. Lead Plumbing Vent Flashings: See Section 07 62 00 – Flashing and Sheet Metal

PART 3 - EXECUTION

3.1 PREPARATION

- A. The Contractor shall confirm conditions at the site and advise the Architect in writing of any conditions which may adversely affect the intended installation.
- B. Inspect for dirt build-up, biological attack, mold, fungus, debris, moss, lichen or other vegetation. Remove any heavy coatings that may form dams and stop natural drainage.
- C. Sweep deck free of dirt and debris.
- D. Work shall proceed at the appropriate time in the sequence of roofing operations. Work shall be coordinated with respect to each trade.
- E. New decking, mortar, and wood nailers are specified under Section 06 10 50 – Roofing Carpentry.

3.2 DEMOLITION AND DECK REQUIREMENTS

- A. Remove existing tiles and salvage for reuse if tile is sound. Remove tile from the roof by lift or crane. Secure tile against slippage and breakage at all time. Store tile at the site in an enclosed locked storage trailer.
- B. Mortar and relace existing decking per Section 06 10 05. Carefully survey the existing tile and replace all unserviceable elements with sound matching components. Replace all deck surfaces with new materials.
- C. Sweep the tiles and substrates free of dirt and debris.
- D. Clean tiles as recommended by tile manufacturer to remove rust and dirt.

3.3 WATERPROOF COATING INSTALLATION

- A. A continuous PMMA waterproof coating shall be adhered to the entirety of the Electric Pump House #3 parapet under the exposed tile per manufacturer's recommendations.
- B. Install in strict accordance with the tile manufacturer's recommendations.

3.4 UNDERLAYMENT INSTALLATION

- A. Self-adhering underlayment shall be applied over the entirety of the wood decks.
- B. Cover Restroom Pavilions A and B pitched roofs parallel to the eave.

-
- C. Install underlayment in strict accordance with the underlayment and tile manufacturer's recommendations.
 - D. All roofing underlayment is to be carried up all vertical surfaces 6 inches minimum.
 - E. Beginning at the eave install the first ply of underlayment over the entirety of the wood deck ensuring full coverage of the deck surface. Lay all sheets parallel to eave unless otherwise directed. Provide 2" side and 6" end laps as required. Lap over eave and rake metals and terminate 0.5" from metal break edge.
 - F. Provide a double layer of underlayment at all hips and ridges and slopes less than 4:12.
 - G. Press underlayment tightly to the deck and along all laps to ensure full adhesion. Turn underlayment up vertical wall surfaces beneath flashing.
 - H. Strip-in metal eave and penetration flanges with an additional ply of underlayment extending a minimum distance of 4" beyond the edge of the flanges.

3.5 TILE INSTALLATION

- A. Establish rules for any foot traffic that may be required for the maintenance of the roof. Clay tile should be walked on as little as possible. Tossing tile from the ground to persons on the roof is unacceptable.
- B. Re-install all salvaged and new tile components in strict conformance with the Manufacturer, TRI and NRCA written installation instructions. Maintain a clean printed copy of the Manufacturer's installation instructions at the jobsite at all times.
- C. Provide treated wood nailers where required.
- D. Lay field tile with exposure matching the historic conditions. Tile shall only be hand nailed. Drive nails flush with tile using caution not to break the tile. Nails shall be set straight and at appropriate locations per Manufacturer's recommendations. All nails shall be concealed in the final work.
- E. Blend the supplemental replacement tile with the existing to provide the greatest contiguous appearance possible at Restroom Pavilion A and Electric Pump House #3.
- F. Lay tiles in straight lines parallel to ground level, lapped according to manufacturer's instructions.
- G. Apply on hips and ridges 1 inch wood stringers of proper height to carry hip rolls and ridge. As required by particular style of tile, cart strip at eaves and covers of tiles. See manufacturer's instructions.
- H. Fasten each tile with 1, 2, or 3 nails as required in each tile or fitting.
- I. Install rake tile ensuring each tile is fully nailed and secure.
- J. Sawcut or neatly break tile at all penetrations installing metal flashings as required.
- K. Cement hip rolls in laps and where they rest on roof tiles. Fasten with 2" nails.
- L. Where tiles join hip stringers, make thoroughly waterproof.
- M. Install hip and ridge tile in a full bed of grout dyed a color matching the field tile.
- N. When hip starter and closer ridge end fittings have not been specified, the voids at ends of hips and ridges shall be filled with mortar colored to nearest match of tile color.
- O. Utilize protective sheeting, lap junctions and secure to make watertight and windproof until roof replacement is completed.
- P. Where ridge angles and hip/ridge terminals are not specified, they shall be mitered of job, nailed or wired and set in elastic cement.

3.6 CLEANING AND PROTECTION OF FINISHED WORK

- A. Remove marks, stains and other unintended elements from all surfaces prior to Substantial Completion. Replace any damaged tile or components.
- B. Consult the Architect and manufacturer(s) of any other surface(s) which may have been damaged or stained for recommended remedies and cleaning instructions. Replace any materials which cannot be cleaned to the Owner's satisfaction.
- C. Provide protection of all surfaces until the work is fully accepted by the Owner.
- D. Leave any excess tile for the Owner upon project completion.

END OF SECTION 07 32 13

SECTION 07 41 13 - METAL ROOF PANELS

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. Work of this Section consists of the supply and installation of preformed metal roofing with flashings, gutters and downspouts at the Pump House as shown on the Drawings.
- B. The Work includes removal of existing metal roof panels, perimeter metal and underlayment; and installation of a new preformed 24-gauge Galvalume double-lock standing seam metal roof with associated underlayment and Galvalume sheet metal flashings.
- C. Related Sections include the following:
 - 1. Section 06 10 00 – Rough Carpentry
 - 2. Section 06 10 50 – Roofing Carpentry
 - 3. Section 06 15 00 – Wood Decking
 - 4. Section 07 51 10 – Roofing Warranty
 - 5. Section 07 59 50 – Roof Removal Procedures
- D. References and Standards
 - 1. SMACNA
 - 2. National Roofing Contractors Association (NRCA) “Roofing and Waterproofing Manual” – applicable sections.
 - 3. ASTM A-792 for Galvalume coated metal.
 - 4. ASTM A-123 for hot-dipped galvanizing on steel products.
 - 5. ASTM A-653 and ASTM A-653M-11 for zinc-coated galvanized steel sheet by the hot-dipped method.
 - 6. ASTM C-920, Type S, Grade NS, Class 25, Use T, NT, M, A, G and O for polyurethane sealant.

1.3 SUBMITTALS

- A. Submit product data for all materials proposed for installation under this Section, including but not limited to each type of underlayment, sheet metal, galvanizing certification, fasteners and sealants.
- B. Submit material safety data sheets (MSDS) for sealants.
- C. Provide a mock-up consisting of the following:
 - 1. The mock-up shall be mounted on a 36” x 36” piece of 5/8” plywood bordered with a 2 x 4 frame.
 - 2. The mock-up shall be a small rendition of the new roof and include rake, hip and head flashings.
 - 3. The mock-up shall include two full-width panels of the required metal and finish covering approximately 27” beginning at the rake edge with a 9” starter panel. The seam between the first and second panels shall be fully locked. Panels shall be folded over the eave and rake flashings as required. The hip and zee flashings shall be provided over the 27” panel width.

4. The mock-up shall be delivered to a location directed by the Architect/Roof Consultant for the Owner's review and approval.
- D. Installer's qualifications and references meeting provisions of Article 1.05.A, below, shall be provided for review. References shall include the contact person, company name, building, telephone number and e-mail address.

1.4 QUALITY ASSURANCE AND QUALIFICATIONS

The installer shall be experienced in the application of this same or similar system and provide evidence of the successful completion of a minimum of five (5) projects completed within the State of Texas of the same type and be a minimum 20,000 sf roof in size.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Materials shall be delivered to the site in crates and containers, on pallets as applicable, and in quantities to allow continuity of application throughout the Work. Schedule and coordinate all necessary deliveries to limit inconvenience or interruption of the Work of others and/or the Owner's continuing use of the site. All deliveries and unloading of materials shall be the sole responsibility of the Contractor. The Owner's representatives and Architect shall not be responsible or requested to assist in receipt of materials.
- B. Non-combustible materials may be stored on the roof when properly protected from damage and the elements. All materials shall be handled in a manner to preclude damage and contamination by moisture or other foreign matter.
- C. Evenly distribute materials on the roof surfaces so as to not exceed 25 pounds per square foot. Metal panels and sheet metal components may not be stored on the roof overnight.
- D. Maintain stored sealants at Manufacturer's recommended temperatures.

1.6 JOB CONDITIONS

- A. Metal roofing work shall not be performed during precipitation or started in the event precipitation is anticipated while the building interior is exposed. The Contractor reserves the final determination as to whether to chance roofing operations when rain threatens.
- B. Materials shall only be applied to dry surfaces. Surfaces intended to receive the work shall be allowed to thoroughly dry before beginning work.
- C. The existing roof and flashings shall not be opened and left exposed overnight without providing temporary measures for waterproofing.

1.7 WARRANTY

- A. The Contractor shall provide a two (2) year warranty covering defects in materials and labor on the form found in Section 07 5110 of these Specifications.
- B. The Manufacturer shall issue its standard 20-year finish warranty for Galvalume finished metals.

PART 2 – PRODUCTS

2.1 METALS

- A. Preformed metal roofing shall be produced from 24-gauge metal and be installed and fastened in the manner indicated hereafter or as shown on the Drawings.
- B. Metal Panel System: Metal roof panels shall have a nominal 1" high double-lock standing seam with 16-1/2" wide pans. Panels shall extend continuously from eave to ridge without interruption or transverse seam.
- C. Clips and Fasteners: Clips shall be 24-gauge galvanized steel. Clips shall be spaced at 12" on center along each standing seam and be fastened with two (2) #12 x 1.5" long stainless steel pancake head screws per clip.
- D. Metal Types and Fastening Criteria:
 - 1. Eave Trim: Produce in shapes and sizes shown on the Drawings. Secure bottom edge on a continuous galvanized cleat. The roof flange shall be 4" in width. Fasten flange with minimum #12 x 1.5" stainless steel pancake-head screws spaced at 3" on center. Lap all joints with sealant pressed in between.
 - 2. Upper Eave / Head Trim: Produce in shapes and sizes shown on the drawings. Hook securely on zee flashing set between panel seams. Provide 4" laps at each joint set in four (4) beads of sealant. See provisions for gravel guard flange in Section 07600.
 - 3. Gutter and Downspouts: Half-round gutters with round downspouts. Produce in shapes and sizes shown on the Drawings and other provisions for gutters and downspouts.
 - 4. Hip Flashing: Produce in shapes and sizes shown on the Drawings. Hook securely on zee flashing on each side of hip. Provide 4" laps at each joint set in four (4) beads of sealant. Do not rivet or otherwise fasten the ridge flashing to the zee flashing or lap joints. Provide closure metal blind riveted in place at lower ends.
 - 5. Zee Flashing: Produce in sizes and shapes shown on the Drawings. Set flange over a continuous sealant bead on the metal panels and secure with three (3) fasteners per pan. Turn sealant up the vertical intersection of the panels and zee flashing on each side.
 - 6. Valleys shall be formed from 24-gauge Galvalume metal and be produced from a stretch-out of 12". Secure the sides with 1-1/2" wide clips folded to provide a nailing tab outside the panel edge. Secure tabs with two (2) screws or roofing nails per tab. Provide a 1" continuous turn-back along the long edges of each side and hook the new metal panels onto the turn-back. Laps shall be minimum 3" in length with three (3) strips of sealant pressed between metal pieces. Terminate the valley at the eave over the top of the new strip-in eave flashing. Terminate the valley at the top below the hip/ridge flashing and seal watertight.

2.2 FASTENERS

- A. Screws: #12 x length required stainless steel screws with heads appropriate for the condition. Provide Phillips-head for all screws.
- B. Neoprene-head Screws: #12 x length required stainless steel screws with hex-head and jacketed neoprene washers.
- C. Blind Rivets: #44SS-long stainless steel blind rivets. Both mandrel and rivet shall be stainless steel.
- D. Roofing Nails: Minimum 11-gauge stainless steel ring-shank nail with 3/8" diameter head.

2.3 MISCELLANEOUS COMPONENTS

- A. Underlayment shall equal TO Carlisle 300HT, or prior approved equal.
- B. Sealant used for all sheet metal shall be single component polyurethane meeting provisions of ASTM C-920, Type S, Grade NS, Class 25, Use T, NT, M, A, G and O for polyurethane sealant.
- C. Pipe flashings shall be one-piece preformed neoprene boots with a stainless steel roof flanges. Boots shall be gray in color.

PART 3 – EXECUTION

3.1 PREPARATION

- A. The Contractor shall confirm conditions at the site and advise the Architect in writing of any conditions which may adversely affect the intended installation.
- B. Work shall proceed at the appropriate time in the sequence of roofing operations. Work shall be coordinated with respect to each trade.
- C. Removal of existing metal roofing, wood shingles, and new decking is specified under Sections 06 1000 and 07 5950.
- D. Upon removal of the existing roof and installation of the new decking the Contractor shall inspect the conditions and inform the Architect in writing of any discrepancies.
- E. All work shall conform to the minimum standards of SMACNA and these Specifications and the Drawings. Where a conflict exists between these standards the Contractor shall advise the Architect in writing before proceeding.

3.2 UNDERLAYMENT INSTALLATION

- A. Start underlayment at the eave edge and lay sheets perpendicular to the roof slope in the longest lengths possible in shingle fashion. Overlap the long edges of each sheet a minimum of 2" and end laps a minimum of 6".
- B. Overlap the underlayment a minimum of 36" to provide a double layer at all valleys, hips and ridges.
- C. Press the underlayment tightly to the new deck. Cut and patch all fishmouths and other anomalies at all laps.
- D. Strip-in all eave and rake flanges with a second 9" wide ply of membrane.

3.3 SHEET METAL INSTALLATION

- A. Install sheet metal components in longest pieces possible not exceeding 10'-0".
- B. Protect metal to be exposed at all times. Dimples, unintended bends, holes and scratches may result in the component being replaced.
- C. Fasten metals as indicated under Part 2 above for each metal type.

- D. Install sealant for each joint to provide a fully watertight connection. Remove excess sealant at all joints where not intended to be exposed.
- E. Provide expansion and/or thermal breaks as specified and/or required.
- F. Fit all joints tightly and neatly.
- G. Neatly form and tool sealants intended to be exposed. Utilize backer rod where required by conditions where no backing is present. Install primer and/or bond breaker tape as required by conditions and bonding requirements.

3.4 METAL ROOF INSTALLATION

- A. Begin new panel installation along the rake edge or at the intersection of valley and ridge as required.
- B. Install metal roof panels. Provide panel clips spaced at 12" on center with two (2) fasteners each as noted above. Begin the clips no more than 4" above the edge of the valley and eaves. Lap the female leg of the seam over the male leg and crimp periodically to retain panels in place. Caution shall be exercised to avoid oil-canning, crimps, folds, warping or waves in the panel face.
- C. Fold the eave ends of panels over the eave flashing and crimp tightly. Leave a 1/4" to 3/8" gap between the panel fold and outside edge of the eave flashing to account for expansion and contraction.
- D. Fold the rake ends of panels over the rake flashing and crimp tightly.
- E. Upon completion of panel installation mechanically fold each seam to a double-lock finish. Use caution when employing the mechanical seamer so as to provide a neat and fully locked seam. Any seams which are damaged or not folded properly shall be removed and replaced at the direction of the Architect.
- F. Install new finished flashings minimizing exposed fasteners to the greatest extent possible.

3.5 CLEANING AND PROTECTION OF FINISHED WORK

- A. Remove markings, stains and other unintended elements from all surfaces prior to Substantial Completion.
- B. Panels and trim which are scratched or otherwise de-faced shall be replaced. Minor scratches, in the sole opinion of the Architect, may remain.
- C. Remove excess and exposed sealant at all joints unless the sealant is specifically shown by the Drawings to remain exposed.
- D. Consult the Manufacturer of the various surfaces which may be damaged for recommended remedies and cleaning instructions. Replace any materials which cannot be cleaned to the Owner's satisfaction.
- E. Remove all protection elements including barricades, tape, fencing, etc., prior to Substantial Completion.
- F. Provide protection of all surfaces until the work is fully accepted by the Owner.

END OF SECTION 07 4113

SECTION 07 51 10 – ROOF WARRANTY

ROOFING WARRANTY

WHEREAS _____ of

Address: _____

herein called the "Contractor", has performed roofing and associated work for the

Project: BRACKENRIDGE PARK REHABILITATION – PHASE 2
Project Address: BRACKENRIDGE PARK
3700 N ST MARY'S ST
(BRACKENRIDGE RD, BRACKENRIDGE DR & N ST MARY'S ST INTERSECTION (NEAR JOSKE PAVILION
& LAMBERT BEACK SOFTBALL FIELD IN THE PARK)
SAN ANTONIO, TX 78209

Owner: CITY OF SAN ANTONIO

Owner Address: 100 W. HOUSTON ST, 15TH FLOOR – PUBLIC WORKS DEPARTMENT

Building: Pump House _____ Electric Pump House #3 _____
Restroom Pavilion A _____ Restroom Pavilion B _____

Date of Acceptance: _____ Date of Expiration: _____

AND WHEREAS the Contractor has contracted with Owner to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period.

NOW THEREFORE the Contractor hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period will at its own cost and expense, make or cause to be made such repairs to, or replacement of said work as is necessary to correct faulty and defective work, and as is necessary to maintain said work in water-tight condition. Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by: (a) lightning, windstorm, hailstorm, and other unusual phenomena of the elements; (b) fire; failure of roofing system substrate including cracking, settlement, excessive deflection, deterioration, and decomposition; (d) faulty construction of vents, mechanical equipment, and other penetrations not installed as part of the work; (e) repeated vapor condensation on bottom of roofing; and (f) activity on roofing by other persons including construction contractors and maintenance personnel, whether authorized or unauthorized by Owner. When work has been damaged by any of the foregoing causes, Warranty shall be null and void until such damage has been repaired by the Contractor, and until cost and expense thereof has been paid for by the Owner, or by another responsible party so designated.
2. The Contractor is responsible for work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks, faults, or defects of the work.
3. During the Warranty Period the Contractor shall be responsible for payment of the Architect and/or Roof Consultant costs to the Owner for investigation of any reported and substantiated leaks or defects in products or workmanship. The Contractor shall not be responsible for these costs if the reported warran-

ty claim is determined not to be the responsibility of the Contractor. However, the Contractor shall be obligated to respond to each reasonably submitted warranty claim presented by the Owner and not be entitled to reimbursement of any cost regardless of the findings.

4. During the Warranty Period, if the Owner allows alterations of work by anyone other than the Contractor, including cutting, patching and maintenance in connection with penetrations, attachment of other work, and positioning of anything on the roof, this Warranty shall become null and void upon date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If the Owner engages the Contractor to perform said alterations, warranty shall not become null and void, unless the Contractor, prior to proceeding with said work, shall have notified the Owner in writing that said alterations would likely damage or deteriorate the work, thereby reasonably justifying a limitation of this Warranty.
5. During Warranty Period, if original use of roof/building is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void upon date of said change, but only to extent said changes affect work covered by this Warranty.
6. The Owner shall promptly notify the Contractor of observed, discovered, or suspected leaks, defect or deterioration, and shall afford reasonable opportunity for the Contractor to inspect the work, and to examine evidence of such leaks, defects or deterioration.
7. This Warranty is recognized to be the only Warranty of the Contractor on said work and shall not operate to restrict or cut off the Owner from other remedies and resources lawfully available in cases of roofing failure. Specifically, this Warranty shall not operate to relieve the Contractor of responsibility for performance of original work.
8. This warranty may transfer to another owner should the building be sold by the original warranty holder (Owner). The Owner shall provide a minimum of thirty (30) days written notification to the Contractor and provide the Contractor ample opportunity to inspect the roof and list any repairs required to maintain the warranty. Any new Owner(s) shall be responsible for the cost of bringing the roof to warrantable condition prior to the transfer of warranty.

In witness thereof, this instrument has been duly executed this _____ Day of _____, 2025

_____	_____
Signature	Company Name
_____	_____
Typed name and Title	Address
_____	_____
Telephone Number	E-mail / Website

Notary Seal

END OF SECTION 07 51 10

SECTION 07 52 16 – TORCH-APPLIED MODIFIED BITUMEN ROOFING

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

Uniform General Conditions, Supplementary General Conditions, Forms, applicable Specification Sections found in all other Divisions, and all Drawings apply to Work specified in this Section.

1.2 DESCRIPTION

- A. The work consists of the supply and installation of a torch-applied reflective surface modified bitumen roof system with flashings at Electrical Pump House # 3.
- B. Upon completion of the work the Contractor shall provide a two-year written warranty on the form found in Section 07 51 00. Provide a Manufacturer's twenty-year no penal sum written warranty covering the roof membrane, insulation and composition flashing systems.

1.3 REFERENCES

- A. Related Specification Sections
 - 1. Section 06 10 50 – Roofing Carpentry
 - 2. Section 07 22 00 – Roof Insulation
 - 3. Section 07 51 10 – Roofing Warranty
 - 4. Section 07 56 00 – Fluid Applied Roofing
 - 5. Section 07 59 00 – Roof Removal Procedures
 - 6. Section 07 62 00 – Sheet Metal Flashing and Trim
 - 7. Section 15 00 10 – Plumbing Provisions
- B. References and Standards
 - 1. Energy Star Rating System
 - 2. 20 International Energy Code
 - 3. ASTM D-6163, Type I, Class S – Standard Specification for SBS Modified Bituminous Sheet Materials using Glass Fiber Reinforcement.
 - 4. ASTM D-5147 – Thickness Measurements of SBS Modified Bituminous Sheet Materials.
 - 5. ASTM D-41 – Asphalt Primer Used in Roofing.
 - 6. FM 1-90 – Factory Mutual Classification for Wind Uplift.

1.4 SUBMITTALS

- A. Submit product data for all materials proposed for installation under this Section, including but not limited to cleaners, primers, coating (base and finish), reinforcement, fasteners, etc.
- B. Provide test reports attesting that the materials proposed for the new membrane system meets the standards of this Section.
- C. Provide Manufacturer's written installation procedures and standard details for installation.
- D. Submit material safety data sheets (MSDS) for all products.
- E. Manufacturer's qualifications and references meeting provisions of Article 5., below, shall be provided for review. References shall include the contact person, company name, building, telephone number and e-mail address.
- F. Installer's qualification and references meeting provisions of Article 5., below shall be provided for review. References shall include the contact person, company name, building, telephone number and e-mail address.
- G. Provide a letter on the Manufacturer's letterhead and signed by a duly authorized employee certifying that all products proposed for the work meet or exceed the specified requirements. The

letter shall further certify that all materials used with the system, whether manufactured by that company or not, are acceptable to the Manufacturer for use with its system. This shall include all insulation products and adhesives. The letter shall also state that the proposed system(s) comply with all criteria required for issuance of the Manufacturer's 20-year warranty. Work may not begin until this letter has been submitted and accepted.

- H. Submit photographic documentation of existing conditions per Article 1.7.A., below.

1.5 QUALITY ASSURANCE AND QUALIFICATIONS

- A. The roof system Manufacturer shall be a company specializing in the manufacture of products under this Section with a minimum ten (10) years of documented experience and a minimum of ten (10) completed projects within the State of Texas of the same type and similar size to this project.
- B. The installer shall be experienced in the application of this same or similar system and provide evidence of the successful completion of a minimum of five (5) projects completed of the same type and minimum 15,000 sf in size. The installer shall be certified in writing by the Manufacturer as being an acceptable applicator trained in the application of its system.
- C. Work of this Section shall strictly conform to the product Manufacturer's installation instructions and these Specifications. One copy of each document shall be maintained at the site at all times work is underway.
- D. A Manufacturer's technical representative shall attend the Pre-Roofing Conference prior to the start of work and conduct a minimum of two (2) site visits to the project during the Work. The same representative shall be maintained throughout the Work if at all possible. Site visits shall be coordinated with a minimum of five (5) working days advance notice with the Architect so each visit is attended by both. Written reports containing the following information shall be forwarded to the Contractor who in turn will forward the reports to the Architect within three (3) working days of each site visit.
1. Reports shall be type-written on the Manufacturer's letterhead stationary or other identifying and acceptable form.
 2. Reports shall document all work on-going at the time of the visit including work in progress, instructions given, identified deficiencies, and other applicable information.
 3. Photographs shall be included with each report.
- E. The Contractor shall maintain a daily log containing the following minimum information.
1. Nature of operation, quantity of work and materials installed, and areas of work.
 2. Personnel by job function and site visitors.
 3. Material deliveries identifying quantity and type.
 4. Daily weather conditions including percentages of rain forecast, actual rainfall, wind conditions and daily temperatures.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Materials shall be delivered to the site in the Manufacturer's original sealed and labeled shrouds and containers, on pallets and in quantities to allow continuity of application throughout the Work. Schedule and coordinate all necessary deliveries to limit inconvenience or interruption of the Work of others and/or the Owner's continuing use of the site. All deliveries and unloading of materials shall be the sole responsibility of the Contractor. The Owner's representatives and Architect shall not be responsible or requested to assist in receipt of materials.
- B. Non-combustible materials may be stored on the roof when properly protected from damage and the elements. All materials shall be handled in a manner to preclude damage and contamination by moisture or other foreign matter.
- C. Evenly distribute materials on the roof surfaces so as to not exceed 25 pounds per square foot. Do not stack materials of any kind on the metal roofs or within ten feet (10') of the open edge of the building with securing same against rolling or blowing off the building. Do not stack materials more than 48" high.
- D. Store primers, adhesives and sealants at temperatures between 50 degrees and 80 degrees F.

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- E. Do not store products inside the building at any time.

1.7 JOB CONDITIONS

- A. No portion of the roof system or its accessories shall be applied during precipitation or started in the event precipitation is anticipated within a 24-hour period following application. The Contractor reserves the final determination as to whether to chance roofing operations when rain threatens. The Contractor shall consider wind speed as a determinate factor as to whether roofing operations can be undertaken safely and without causing damage to the building or vehicles.
- B. Coordinate all communication movement and relocations with the communications vendors.
- C. Temporary masking of vertical surfaces, HVAC equipment, etc., shall be employed to protect surfaces.
- D. Materials shall only be applied to dry surfaces. Existing roof surfaces shall be allowed to thoroughly dry before beginning work.
- E. The existing roof membrane and flashings shall not be opened and left exposed overnight without providing temporary measures for waterproofing.
- F. A minimum of two (2) fully charged and workable ABC Class Fire extinguishers shall be maintained at the roof level at all times work is underway. All workers shall be skilled in proper fire extinguisher use.
- G. Upon completion of work each day that torching operations occur, the Contractor shall provide a fire watch for a minimum of one hour by a competent person trained to detect possible smoke or fire resulting from the roofing operations. Should the competent person detect smoke or fire he shall immediately place a telephone call to the fire department through the 911 exchange.
- H. The Contractor shall maintain a daily log with the following information:
1. Nature of operation and quantity of work and material for each area installed.
 2. Personnel on site by job function and task. Also maintain a list of all site visitors.
 3. Material deliveries identifying quantity and type.
 4. Daily weather conditions including percentages of rain forecast, actual rainfall, wind conditions and daily temperatures.
- I. Materials which have not been approved through the submittal process shall be prohibited from being brought onto the project site. If any such materials are brought to the site they shall be identified and removed immediately. Any materials incorporated into the work which have not been approved through the submittal process may result in that work being removed and replaced without appeal or exception.

1.8 PRE-ROOFING CONFERENCE

- A. The Contractor, each Subcontractor, the Project Manager, the Manufacturer's Representative, and proposed full-time Project Superintendent shall attend a Pre-Roofing Conference a minimum of ten (10) days prior to start of work. The Architect and Owner's Representative shall also attend.
- B. The agenda shall cover procedures for the work in general, installation procedures, staging and material storage locations, site access, coordination and other related work. The Contractor shall produce detailed minutes of the meeting and submit a copy by e-mail to each attendee within three (3) working days of the meeting.

1.9 WARRANTY

- A. The roofing system Manufacturer shall provide a 20-year no penal sum (no dollar) warranty covering all membrane and insulation materials.
- B. The Contractor shall provide a five (5) year warranty covering defects in materials and labor on the form found in Section 07 51 00 of these Specifications.
- C. Manufacturer warranties may not include the following exclusions and/or refusals:
1. Refusal to issue the warranty if not fully paid for all materials. It is expected that all parties shall exercise lien rights as necessary for relief by the Surety.
 2. Refusal to issue the warranty if the project is not performed by an authorized installer of the products. The Manufacturer, through its certification of the Contractor, waives its right to this

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- claim. The Contractor further agrees to abide by the terms of the Manufacturer by installing the work with craftsmen, materials and methods approved in advance by the Manufacturer.
3. Refusal to issue the warranty if the project is not inspected by the Manufacturer's approved inspector.
 4. Refusal to effect repairs to the roof system should the Owner not give written notice within thirty (30) days of discovery of a warranty-related issue, or when such issue should have been discovered. The Owner will only endeavor to notify the Manufacturer and/or Contractor within thirty (30) days of discovery of any leak reasonably attributable to the roof. However, if the Owner does not notify the Manufacturer within ninety (90) days of its discovery the Manufacturer may elect to assess the cost for the repair.
- D. Any claim, dispute or litigation shall occur within a competent court of law in Bexar County, Texas and be adjudicated under the laws of the State of Texas.

PART 2 - PRODUCTS

2.1 MEMBRANE MATERIALS

- A. Modified Bitumen Base Sheet: Fiberglass-reinforced matt coated with SBS modified asphalt for torch application.
- B. White Reflective Surface Modified Bitumen Cap Sheet: Fiberglass and/or polyester-reinforced matt coated with SBS modified asphalt and white reflective surfacing for torch application.
- C. Base Flashings: Fiberglass-reinforced matt coated with SBS modified asphalt and aluminum foil-clad surfacing for torch application.
- D. Basis-of-Design or Approved Equal Manufacturer and System:
 1. Siplast
 - a. Paradiene 20 TG base ply
 - b. Paradiene 30 FRTGBW cap sheet
 2. Prior approved equal

2.2 BITUMINOUS MATERIALS

- A. Asphalt Primer: ASTM D-41.
- B. Plastic Roof Cement: ASTM D-4586, Type I; asbestos free.
- C. Flashing Cement: Compatible with SBS modified bitumen roof system.

2.3 FLEXIBLE FLASHINGS

- A. Sheet Flashing: Embossed aluminum foil clad or reflective film surfaced fiberglass-reinforced matt APP or SBS modified bitumen membrane for torch application. Flashings shall be provided by the same manufacturer of the roof membrane system.
- B. Scupper flashing: Basis-of-Design Siplast Parapro or approved equal.
- C. Backer Ply: Fiberglass-reinforced matt coated with SBS modified asphalt for torch application.

2.4 ACCESSORIES

- A. Roofing Nails: 11-gauge stainless steel wire nails with 3/8" diameter heads and annular rings; length required to penetrate the substrate nailer a minimum of 3/4".
- B. Mechanical fasteners for flexible flashing:
 1. Masonry or concrete substrate: 12-gauge or 1/8" x 1" hot-dipped galvanized steel bar stock anchored with 0.25" x 1.5" zinc-jacketed masonry steel drive pin equal to Zamac Hammer Screw. Provide with Phillips head.
 2. Wood substrate: Equal to Simplex hot-dipped galvanized ring-shank cap nails with 1" minimum diameter round heads.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify site conditions to ensure surfaces are ready to receive the work.
- B. Inspect nailers, curbs and insulation to ensure conditions are ready for the new membrane. Verify that the deck/insulation is clean and smooth, free of depressions and sloped so as to eliminate ponding water, are free of unintended projections.
- C. Confirm that deck/insulation surfaces are dry and free of moisture. Utilize recommended NRCA dryness test if required.
- D. Verify that roof openings, curbs, pipes, sleeves, ducts, vents and any other penetration/feature on the roof are solidly anchored and that all required wood nailers are at the appropriate height.
- E. The beginning of installation shall constitute acceptance of existing conditions under which the work will be performed.

3.2 PREPARATION

- A. Roll goods and other heavy materials shall be delivered to the roof surface via crane. Combustible materials other than propane tanks may not be delivered to the roof via the elevator.
- B. Protect all building surfaces against damage from roofing operations.
- C. Prevent debris from entering scuppers, downspouts, drains, underside of the roof deck, and/or other openings. Remove temporary closures from all drainage devices before leaving the site each day.
- D. Clean deck/insulation surfaces and maintain dust and debris free during roofing operations.

3.3 MANUFACTURER'S DETAILING

- A. The following Siplast details shall apply to the work. In the event a detail is not listed the Contractor shall consult the Siplast installation instructions and the Architect to determine the appropriate detail to be incorporated in the work.
- B. Details
 - 1. Insulated Curb – 2030 – Rigid
 - 2. Expansion Joint – Roof-to-Roof – 2030 – Rigid
 - 3. Scupper – 2030 – Ppro – Similar
 - 4. Overflow Scupper – 2030 – Ppro
 - 5. Roof Edge – 2030 – Rigid
 - 6. Waste Stack – 2030 – Rigid - Ppro
 - 7. Penetration – 2030 – Rigid – Ppro
 - 8. Parapet Coping – 2030 – Rigid up to 24"
 - 9. Adh - High Parapet Coping – 2030 – Rigid

3.4 MEMBRANE ROOF SYSTEM APPLICATION

- A. Work shall begin during or immediately following installation of wood blocking and insulation. Insulation and the building interior shall not be left exposed overnight without prior written permission from the Architect.
- B. Roll out modified bitumen base ply and cap sheets approximately 30 minutes prior to application and allow rolls to relax. Re-roll sheets just prior to application. Weight the rolled out sheets on the roof to prevent displacement by wind or rolling.
- C. Installation shall comply with the Manufacturer's written installation instructions.
- D. Starting at the low point of the roof lay the modified bitumen base ply perpendicular to the roof slope and torch in place over the insulation substrate. Provide for 3" minimum end and side laps. Fully and continuously torch apply each sheet. Torch the membrane uniformly to ensure full adhesion of each sheet. Lightly trowel the edges of each sheet. Do not walk or stand on the newly installed base ply until it has cooled adequately. Extend the plies to the top of the cant and seal watertight

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- with the backer ply or flashing cement as a temporary seal. Stagger end laps a minimum of 12" between successive rows.
- E. Apply one 36" wide temporary modified bitumen base sheet ply a minimum of 12" beyond the insulation and onto the existing roof membrane to serve as a temporary overnight tie-in. Remove tie-ins prior to work resuming work.
 - F. Torch-apply one ply of modified bitumen base sheet at each curb penetration. Extend the ply a minimum of 4" onto the roof from the bottom edge of the cant and terminate at the top of the curb or detailed location on walls.
 - G. Set flanges of metal penetration flashing and gravel guard in a full 1/8" thick bed of flashing cement and nail at 3" on center staggered. Lead flashings do not require nailing. Strip-in the flanges with a minimum 9" wide ply of torch-applied modified bitumen base sheet.
 - H. Apply the modified bitumen cap sheet parallel to the base ply in accordance with the Manufacturer's written instructions. Fully torch the cap sheet to the base sheet providing minimum 3" side and end laps. Stagger lap joints between the base sheet and cap sheet at least 12". Stagger laps between adjacent plies of cap sheet by 12" minimum.
 - I. Limit bitumen bleed at sheet laps to no more than 0.5". Lightly trowel the edges of each sheet while the bitumen remains hot and cover all exposed bitumen with reflective paint per the Manufacturer's instructions. Stripping-in of flanged penetration flashings will not be permitted.
 - J. Apply Parapro flashings at all penetrations and scuppers.

3.5 FLEXIBLE BASE FLASHING APPLICATION

- A. Torch-apply the new foil-clad membrane over the new backer ply and cap sheet at all vertical curb and wall intersections. Installation shall comply with the Manufacturer's written installation instructions. Extend the new membrane from a line 4" beyond the toe of the cant, over the cant and onto the vertical surface. The minimum termination height of all base flashing shall be 8" above the finished roof surface or as otherwise shown on the Drawings.
- B. Maintain the toe of the flashing in a straight line on the roof surface. Provide minimum 3" side laps. Do not torch new membrane over foil-clad surfaces. Limit bitumen bleed at sheet laps to no more than 0.25". Lightly trowel the edges of each sheet while the bitumen remains hot and cover all exposed bitumen with aluminum dust.

3.6 FIELD QUALITY CONTROL

- A. Field inspection and testing shall be performed when required by the Architect.
- B. At any point during application, or upon Substantial Completion of the work, the Architect with Owner approval may have the work inspected and tested by a third-party laboratory/testing company using applicable methods to establish conditions in the new roof installation. Up to three roof cuts may be taken at the from the roof assembly. The Contractor shall assist in performing the roof cores as required and shall patch the roof to the finished condition once the cores are removed for no additional cost.
- C. The Contractor shall promptly remedy all deficiencies, defects and irregularities in the work.
- D. Membrane defects which may allow water penetration shall be repaired prior to leaving the site each day.

3.7 CLEANING

Remove bituminous and other markings and stains from all finished surfaces prior to Substantial Completion. Clean any areas soiled by bitumen or other sources per the Manufacturer's guidelines. Replace materials and/or finishes which cannot be cleaned to the Owner's satisfaction.

3.8 PROTECTION OF FINISHED WORK

- A. Protect the finished work from damage at all times.
- B. Provide roof surface protection per Section 06 10 50.

END OF SECTION 07 52 16

SECTION 07 56 00 – FLUID-APPLIED ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The project plans, details and general Contract requirements apply to this Section.

1.2 DESCRIPTION

- A. A. Work of this Section includes the cleaning, preparation and coating of the vertical and horizontal surfaces of the Electric Pump House #3 parapet are included in the work.
- B. The new coating system shall consist of a multi-coat white liquid applied acrylic elastomeric roof coating.
- C. A Manufacturer's 20-year warranty shall be provided for the finished work.

1.3 SUMMARY

A. Items Included:

1. Base sheet.
2. Roof insulation.
3. Cover panel.
4. SBS modified bituminous membrane roofing.
5. PMMA Fluid-applied Roofing
6. Walktread.

B. Related Sections:

1. Section 06 10 50 - Roof Carpentry for wood nailers, curbs, and blocking, and for wood-based, structural-use roof deck panels.
2. Section 06 16 00 - Sheathing for wood-based, structural-use roof deck panels.
3. Section 07 52 16 – Torch-Applied Modified Bitumen Membrane Roofing
4. Section 07 62 00 - Sheet Metal Flashing and Trim for shop and field formed metal roof flashings and counter flashings, fabricated metal copings, roof edge fascia, gravel stops, reglets, roof edge flashings, and counter flashings.
5. Section 07 92 00 - Joint Sealants for joint sealants, joint fillers, and joint preparation.

1.4 REFERENCES

- A. References in these specifications to standards, test methods and codes, are implied to mean the latest edition of each such standard adopted. The following is an abbreviated list of associations, institutions, and societies which may be used as references throughout this specification section.

1. ASTM: American Society for Testing and Materials
2. FM: Factory Mutual Engineering and Research
3. NRCA: National Roofing Contractors Association
4. OSHA: Occupational Safety and Health Administration
5. SMACNA: Sheet Metal and Air Conditioning Contractors National Association
6. UL: Underwriters Laboratories
7. ACI: American Concrete Institute
8. ICRI: International Concrete Repair Institute

9. SSPC: The Society for Protective Coatings

1.5 PREINSTALLATION MEETINGS

- A. Pre-installation Roofing Conference at Jobsite: Hold a meeting with the Owner, Construction Manager, Architect, Roofing Contractor, Roofing Manufacturer's Representative, and other applicable trades to discuss the means and methods related to roofing installation. The Roofing Contractor shall examine the substrate that will receive the specified roofing materials and confirm its suitability for attachment of the specified roofing system.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
 1. Installer: Submit written confirmation that they have a minimum of 2 years of experience in successfully installing the same or similar roofing materials and be certified in writing by the roofing materials manufacturer to install the primary roofing products.
 2. Manufacturer: Submit written confirmation that the manufacturer of the primary roofing products has been successfully producing the specified types of primary products for not less than 10 years with a consistent composition for a minimum of 5 years.
- B. System Qualification:
 1. Intent to Warrant Letter: Submit a signed letter on the roof membrane manufacturer's letterhead, confirming that specified roofing system complies with the guarantee requirements indicated in Part 1.11 and the criteria indicated in Part 2.2 Roof Membrane Sheet Materials.
 2. Sample Guarantee: Submit a sample copy of the manufacturer's proposed Guarantee.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Submit the manufacturer's care and maintenance guide.
- B. Executed Guarantee: Provide the Owner with an executed version of the specified guarantee.

1.8 QUALITY ASSURANCE

- A. Fire Rating: Submit evidence of exterior fire-test exposure by an approved third-party testing agency in accordance with ASTM E108 or UL 790 guidelines.
 1. Class A
- B. Hail Rating: Submit evidence by FM Global that the roof configuration has been tested to meet the following specified hail resistance design.
 1. Class 1-SH (severe hail) exposure.
- C. Wind Uplift Rating: Submit evidence by an approved third-party testing agency that the roof configuration has been tested to meet the following specified wind uplift design.

1. Class 1, 1-90 windstorm construction.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: 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, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Storage: Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing manufacturer.
 1. Protect stored liquid material from direct sunlight, heat, open fire, ignition sources, oxidizing agents, strong acids, and strong alkalis.
 2. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Protection: Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Comply with the insulation manufacturer's written instructions for handling, storing, and protecting materials during installation.
- D. Handling: Handle and place roofing materials and equipment in a manner to avoid permanent deflection of deck.

1.10 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing to be installed in accordance with manufacturer's written instructions and warranty requirements.
- B. Membrane Protection: Provide protection against staining and mechanical damage for newly applied roofing and adjacent surfaces throughout this project.
- C. Debris Removal: Remove all debris daily from the project site and take to a legal dumping area authorized to receive such materials.
- D. Site Condition: Complete, to the owner's satisfaction, all job site clean-up including building interior, exterior and landscaping where affected by the construction.

1.11 GUARANTEE

- A. Manufacturer's Guarantee: Provides that the Manufacturer will repair leaks through the covered roofing materials due to material or workmanship defects, subject to certain exclusions, during the specified time period. Refer to guarantee for complete coverage and restrictions.
 1. The Guarantee shall provide coverage for the roofing membrane, base flashings, roof insulation, fasteners, insulation adhesive, and cover panel. The Guarantee shall be non-prorated and contain no deductibles or limitations on coverage amount.
 2. Guarantee Period: 20 years from date of Substantial Completion.
- B. Special Project Warranty: Submit roofing contractor's warranty signed by the Installer, including all components of the roofing and insulation system for the following warranty period:
 1. Warranty Period: 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: A roof system by the following manufacturer is approved for application.

1. Siplast, Inc.

2.2 ROOFING MEMBRANE SHEET MATERIALS

A. Base Ply: An ASTM D6163, Type I, Grade S homogenous membrane with a glass-fiber reinforcing mat impregnated/saturated and coated each side with SBS modified bitumen blend with a factory applied polymer modified asphalt self-adhesive on the back surface of the sheet to provide full adhesion to the total surface area of the substrate. The back side of the base ply shall be surfaced with a removable film. The cross sectional area of the sheet material shall contain no oxidized or non-SBS modified bitumen. The base ply shall be surfaced with a factory-applied acrylic coating and possess the following physical/mechanical properties.

1. Thickness (avg): 102 mils (2.6 mm) (ASTM D5147)
2. Thickness (min): 98 mils (2.5 mm) (ASTM D5147)
3. Weight (min per 100 ft² of coverage): 69 lb (3.4 kg/m²)
4. Peak filler content in elastomeric blend - 35% by weight
5. Low temperature flexibility @ -15°F (-26°C): PASS (ASTM D5147)
6. Peak Load (avg) @ 73°F (23°C): 30 lbf/inch (5.3 kN/m) (ASTM D5147)
7. Peak Load (avg) @ 0°F (-18°C): 75 lbf/inch (13.2 kN/m) (ASTM D5147)
8. Ultimate Elongation (avg.) @ 73°F (23°C): 50% (ASTM D5147)
9. Compound Stability (max): 0.1% (ASTM D5147)
10. High Temperature Stability (min): 250°F (121°C) (ASTM D5147)

> Pro Base SA by Siplast, Inc.

B. Resin for Finish Ply Membrane Construction: A multi-component, fast-curing, flexible PMMA-based resin for use in combination with fleece fabric to form a monolithic, reinforced roofing membrane. Physical and mechanical values are based on testing/evaluation of a 90-mil (2.3 mm) PMMA roof membrane reinforced with the specified fleece reinforcement.

1. Thickness (avg): 90 mils (2.3 mm) at 0.31 kg/ft² (3.3 kg/m²) coverage rate (ASTM D5147, section 5).
2. Peak Load (avg) @ 73°F (23°C): 70 lbf/in (12.3 kN/m) (ASTM D5147 section 6)
3. Peak Load (avg) @ 73°F (23°C): 90 lbf/inch (15.8 kN/m) (ASTM D412, dumbbell)
4. Elongation at Peak Load (avg) @ 73°F: 35% (ASTM D5147, section 6)
5. Elongation at Peak Load (avg) @ 73°F: 35% (ASTM D412, dumbbell)
6. Shore A Hardness (avg): 81 (ASTM D2240)
7. Water Absorption, Method I (24h @ 73°F): 0.8% (ASTM D570)
8. Water Absorption, Method II (48h @ 122°F): 1.2% (ASTM D570)
9. Low temperature flexibility @ 23 F (-5°C): PASS (ASTM D5147, section 11)
10. Dimensional Stability (max): 0.15% (ASTM D5147, section 10)
11. Tear Strength (avg): 90 lbf (0.4 kN) (ASTM D5147, section 7)

12. Approvals: UL Class listed, FM Approved (products shall bear seals of approval)

> Parapro Roof Resin by Siplast, Inc.

C. Fleece for Membrane Reinforcement: A non-woven, 110 g/m², needle-punched polyester fabric reinforcement as supplied by the membrane system manufacturer.

> Pro Fleece by Siplast, Inc.

2.3 BASE FLASHING SHEET MATERIALS

A. Stripping and Flashing Reinforcing Ply: An ASTM D6163, Type I, Grade S homogenous membrane with a glass-fiber reinforcing mat impregnated/saturated and coated each side with SBS modified bitumen blend with a factory applied polymer modified asphalt self-adhesive on the back surface of the sheet to provide full adhesion to the total surface area of the substrate. The back side of the base ply shall be surfaced with a removable film, and the top of the sheet shall be surfaced with a factory-applied acrylic coating.

1. Pro Base SA by Siplast, Inc.

B. Liquid Flashing System: The specified liquid flashing system shall consist of a catalyzed PMMA-based membrane fully reinforced with a non-woven polyester fleece that is installed over a prepared or primed substrate.

1. Parapro 123 Flashing by Siplast, Inc.

2.4 BITUMINOUS MEMBRANE PRIMERS

A. Asphalt Primer: Primer shall meet ASTM D41 criteria.

1. PA-1125 Asphalt Primer by Siplast, Inc.

B. Primer for Self-Adhesive Membranes: Primer for self-adhesive membranes shall be a single component, water-based resinous primer formulated to condition masonry, wood, plywood, concrete, asphaltic, and gypsum surfaces to facilitate adhesion of self-adhesive membranes.

1. TA-119 Primer by Siplast, Inc.

2.5 AUXILIARY ROOFING MATERIALS

A. Sealant: A moisture-curing, self-leveling elastomeric sealant designed for roofing applications.

1. PS-209 Elastomeric Sealant

B. Sealant: A moisture-curing, non-slumping elastomeric sealant designed for roofing applications.

1. PS-715 NS Elastomeric Sealant

C. Base Sheet Fasteners for Wood/Plywood Decks:

1. A 12 gauge, spiral or annular threaded shank, zinc coated steel roofing fastener having a minimum 1 inch metallic head.

- a. Simplex Cap Nail by Simplex Nails, Inc.

2.6 BASE SHEET FOR NAILABLE SUBSTRATES

- A. Base Sheet: A fiberglass reinforced, asphalt coated sheet with a polyolefin film backing, having a minimum weight of 20 lb/sq. The sheet shall conform to ASTM D 4601, Type II requirements.

1. Parabase FS by Siplast, Inc.

2.7 ROOF INSULATION

- A. General: Insulation shall be approved in writing by the insulation manufacturer for intended use and for use with the specified roof assembly. Maintain a maximum panel size of 4 feet by 4 feet where polyisocyanurate insulation is specified to be installed in insulation adhesive. Install only as much insulation as can be made watertight during the same work day.

- B. Polyisocyanurate Board Insulation (inorganic coated glass facer): A closed cell, rigid polyisocyanurate TCPP-free Non-halogenated foam core material, integrally laminated between polymer bonded glass fiber facers, and meeting the criteria established by ASTM C1289, Type II, Class 1, Grade 3. Two layers of Panels each having a nominal thickness of 2.2 inches. Acceptable types are as follows:

1. Paratherm NH CG by Siplast, Inc.

- C. Tapered Polyisocyanurate Board Insulation (inorganic coated glass facer): A closed cell, rigid polyisocyanurate TCPP-free Non-halogenated foam core material, integrally laminated between glass fiber reinforced organic facers, and meeting the criteria established by ASTM C1289, Type II, Class 1, Grade 2. The tapered system shall incorporate fill panels of a nominal thickness and provide for a roof slope of 1/8 inch. Acceptable types are as follows:

1. Tapered Paratherm NH CG system by Siplast, Inc.

2.8 INSULATION COVER PANEL

- A. Gypsum Sheathing Panel: A panel composed of a gypsum based, non-structural water resistant core material integrally bonded with fiberglass mats on both sides having a nominal thickness of 1/2 inch. The panel surface shall be factory primed with a non-asphaltic primer. Acceptable types are as follows:

1. DensDeck Prime Gypsum Roof Board, by Georgia Pacific Corporation

- B. Substrate Board (Alternate): A non-structural gypsum panel composed of fiber reinforced synthetic gypsum. Provide panels having a nominal thickness of 1/2 inch. Acceptable types are as follows:

1. Securock Gypsum Fiber Roof Panel by United States Gypsum Corporation

2.9 INSULATION ACCESSORIES

- A. Insulation Fasteners: The insulation fasteners shall provide attachment required to meet the specified uplift performance and to restrain the insulation panels against the potential for ridging.
- B. Insulation Fasteners - Wood/Plywood Decks: Insulation mechanical fasteners shall be a fluorocarbon coated screw type roofing fastener having a minimum 0.220 inch thread diameter. Plates used in conjunction with the fastener shall be a metal type having a minimum 3 inch diameter, as supplied by the fastener manufacturer.. The fastener shall conform meet or exceed Factory Mutual Standard 4470 and when subjected to 30 Kesternich cycles, show less than 15% red rust. Acceptable insulation fastener types for wood/plywood decks are listed below.
 - 1. Parafast Fastener by Siplast, Inc.
 - 2. Standard RoofGrip Drill Point Fastener by OMG
- C. Insulation Adhesive: single or dual component low-rise polyurethane foam adhesive designed specifically for the adhesion of roof insulation to substrate, as well as subsequent layers of insulation. Acceptable manufacturers are as follows:
 - 1. Para-Stik by Siplast, Inc.
 - 2. Parafast Insulation Adhesive by Siplast, Inc.
- D. Tapered Edge Strips: A tapered panel composed of expanded volcanic minerals combined with waterproofing binders. The top surface shall be pre-treated with an asphalt based coating. The panels shall have a dimension sufficient to provide for a smooth transition and provide proper support for the membrane layer or subsequent layer of insulation when there are transitions of 1/4 inch or greater.

2.10 RESIN ACCESSORIES

- A. Cleaning Solution/Solvent: A clear solvent used to clean and prepare transition areas of in-place catalyzed resin to receive subsequent coats of resin and to clean substrate materials to receive resin.
 - 1. Pro Prep by Siplast, Inc.
- B. Preparation Paste: A PMMA-based paste used for remediation of depressions in substrate surfaces or other irregularities.
 - 1. Pro Paste Resin by Siplast, Inc.
- C. Repair Mortar: A two-component, PMMA-based, aggregate filled mortar used for patching concrete substrates.
 - 1. Pro Mortar by Siplast, Inc.
- D. Thixotropic Agent: A liquid additive used to increase the viscosity of the PMMA-based resin products, allowing the resins to be applied over sloped substrates.
 - 1. Pro Thixo by Siplast, Inc.
- E. Color Finish Resin: A pigmented, PMMA-based resin for used to provide a color finish for both field and flashing membranes.
 - 1. Pro Color Finish by Siplast, Inc.

- F. Catalyst: A peroxide-based reactive agent used to induce curing of PMMA-based resins.
 - 1. Pro Catalyst Powder by Siplast, Inc.
 - 2. Pro Catalyst Liquid by Siplast, Inc.
- G. Primers for PMMA Resin-based Roof Membrane and Flashing
 - 1. Primer for Wood, Plywood and Rigid Insulation, Masonry and Vertical Concrete Substrates: A fast-curing PMMA-based primer for use in over wood, plywood and rigid insulation substrates.
 - > Pro Primer W by Siplast, Inc.
- H. Accessories
 - 1. Ceramic Granule Anti-Skid Surfacing: No. 11 grade specification ceramic granules suitable for broadcast into a PMMA-based resin wearing layer.
 - > No. 11 Granules by Siplast
 - 2. Glass Beads: A natural-colored glass bead for broadcast into the color finish layer of the waterproofing system to generate a skid resistant surface. Glass beads shall be supplied by the manufacturer of the waterproofing membrane.
 - > Pro Texture Beads by Siplast, Inc.
- I. Joint Tape: A thermoplastic/rubber based sheet having a woven polyester backing used to treat joints between rigid insulation, flashing substrate panels and joints at cover plates used over sheet metal components. The tape shall have a minimum width of 4 inches.
 - 1. Eternabond Webseal by Eternabond, Inc.
- J. Spray Primer for Stainless Steel, Aluminum and Copper Substrates: An enamel spray primer for metal substrates to receive PMMA-based flashings.
 - 1. Rust-Oleum™ High Performance V2100 System Enamel Spray Primer by Rust-Oleum™, Vernon Hills, IL

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Substrate Qualification: The installing contractor shall examine all substrates where the specified roofing and flashing system will be applied and confirm their suitability to receive the specified roofing materials.

3.2 PREPARATION

- A. Sweep or vacuum all surfaces, removing all loose aggregate and foreign substances prior to commencement of roofing.
- B. Remove all of the following existing conditions:

1. Surface gravel
 2. Roof membrane
 3. Insulation
 4. Base flashings
 5. Edge metal
 6. Flanged metal flashings
 7. Cants
 8. Walkways
 9. Nonfunctional penetrations/curbs
 10. Drain assemblies
 11. Vapor retarder
 12. Metal trim, counter flashing
- C. Primer for Self-Adhesive Flashing Reinforcing Ply: Apply the specified tacky primer by roller or spray in an even film. Refer to the manufacturer's literature for the approved rate of application over various substrate types. Allow the primer to dry until it leaves a slightly sticky surface without transfer when touched. Cutting or alteration of the primer is not permitted.
- D. Asphaltic Primer for Modified Bituminous Sheets: Prime metal and concrete and masonry surfaces with a uniform coating of the specified asphalt primer according to the manufacturer's published application rate. Cutting or alteration of the primer is not permitted.
- E. Preparation of Steel Substrates: Grind to generate a "bright metal" surface and remove loose particles. Extend preparation area a minimum of 1/2-inch (13 mm) beyond the termination of the roofing/flashing system. Notch steel surfaces to provide a rust-stop where detailed.
- F. Preparation of Stainless Steel, Aluminum and Copper Substrates: Hand tool (SSPC-SP-2) or power tool (SSPC-SP-3) clean to remove loose rust, mill scale, and deteriorated previous coatings as well as to generate a tooth. Protect surrounding surfaces from overspray. Shake can for one minute after mixing ball is heard. Hold can 10-14 inches from surface. Apply several light coats a few minutes apart to avoid drips and runs. Recoat within 1 hour or after 24 hours; allow more time in cooler temperatures. Monitor ambient and substrate temperatures/conditions to ensure that they are within the paint manufacturer's acceptable range.
- G. Rigid Plastic Flashing Substrates: Evaluate the plastic for compatibility with the resin materials. Lightly abrade the surface to receive the flashing system, clean plastic substrates using the specified the cleaner/solvent and allow to dry. Extend the preparation area a minimum of 1/2 inch (13 mm) beyond the termination of the flashing system.
- H. Preparation of Wood/Plywood Flashing Substrates to receive Resin: Prime wood/plywood surfaces to receive the specified flashing system with the specified PMMA-based primer at the rate specified by the resin manufacturer and allow primer to cure. Tape the joints between plywood or wood panels using gaffer's tape prior to application of the lashing system.

3.3 INSTALLATION OF ROOFING, GENERAL GUIDLEINES

- A. General Appearance: Ensure that the finished roofing application has an aesthetically pleasing overall appearance and is acceptable to the Owner.

3.4 INSTALLATION OF BASE SHEET

- A. Lay the base sheet over entire area to be roofed, lapping sides 3 inches and ends 6 inches. Using the specified fasteners, fasten each sheet every 9 inches through laps and stagger fasten the remainder of the sheet in 2 rows on nominal 12 inch centers with fasteners in each row on 12 inch centers.

3.5 INSTALLATION OF INSULATION AND COVERBOARD

- A. Install insulation panels with end joints offset with edges in moderate contact in accordance with the insulation manufacturer's requirements. Where insulation is installed in two or more layers, stagger joints between layers. Maintain a maximum panel size of 4 feet by 4 feet for polyisocyanurate / fiberboard insulation applied in insulation adhesive or hot asphalt. Install only as much insulation as can be made watertight within the same work day.
- B. Crickets: Construct crickets of tapered insulation panels in a layout as indicated on the roof plan.
- C. Tapered Edge at Transitions: Field-cut, shape and install tapered edge strip at transitions of 1/4 inch or greater between substrate components to provide a smooth transition and proper support for the subsequent insulation layer or membrane/flashing system components.
- D. Insulation - multiple layer: Mechanically attach the base layer simultaneously to the substrate, using the specified fasteners, at a rate of 1 fastener for every 4 square feet of panel area (8 per 4' x 8' panel). Mechanically attach the perimeter of the roof at the rate of 1 fastener per 2 square feet of panel area (16 per 4-foot by 8-foot panel) and the corners at the rate of 1 fastener per 1 square foot of panel area (32 per 4-foot by 8-foot panel). Set the subsequent layers of insulation in an application of the specified insulation adhesive in 3/4- to 1-inch wide beads spaced 12 inches on center in the field of the roof, 8 inches on center at the perimeter of the roof, and 6 inches on center in the corners of the roof. Panels may be affected by post-growth of the insulation adhesive. Continuous walking in of the panels is recommended particularly in perimeter/corner areas with reduced bead spacing. Follow the requirements and guidelines of the insulation adhesive manufacturer. Stagger the panel joints between insulation layers.

3.6 APPLICATION OF BITUMINOUS ROOFING MEMBRANE

- A. Apply the modified bitumen ply sheet with side laps running perpendicular to the direction of the slope. Exert sufficient pressure on the roll during application to ensure prevention of air pockets, wrinkles, creases or fishmouths. Refer to the manufacturer's guidelines for maximum sheet lengths and special fastening of the head laps where the roof deck slope exceeds 1/2 inch per foot.
- B. Unroll the base ply, and set the roll into place utilizing minimum 3 inch side and end laps. Fold one end of the roll back onto itself by 24 inches. Peel the release film off of the back of the 24 inch end section of the sheet and lay into place, pressing the 24 inch end section of the sheet firmly into place over the substrate. Pull the release film free from the underside of the remainder of the sheet while pressing the material into place with a follow tool as the film is being removed, leaving the end laps unadhered. Prior to adhering the end laps, cut a dog ear angle at each end lap on overlapping selvage edges. Torch seal or heat weld end laps, ensuring that the self-adhesive blend on the

underside of the overlapping sheet and the top surface of the underlying sheet flow into a layer of continuously bonded or fused modified bitumen. Using a clean trowel, apply top pressure to top seal T-laps immediately following sheet application. Stagger end laps a minimum of 3 feet. Laps of the base ply shall not be left exposed overnight. The base ply application shall be immediately followed by the application of the finish ply. A phased application between the base and finish plies is not approved. In cases where rapid onset of inclement weather occurs, seal exposed lap edges with a torch or hot-air welder and trowel.

3.7 APPLICATION OF BITUMINOUS STRIPPING

- A. Apply the specified base flashing materials in accordance with the manufacturer's standard details. Notify the design team immediately of any flashing heights below 8 inches. Flash walls and curbs using the reinforcing sheet. Exert pressure on the flashing reinforcing sheet during application to ensure complete contact with the vertical/horizontal surfaces, preventing air pockets. Check and seal all loose laps and edges. Nail the top edge of the flashing reinforcing on 9 inch centers. Install the specified liquid-applied flashing system in accordance with the membrane system manufacturer's printed installer's guidelines and other applicable written recommendations as provided by the manufacturer. (See the manufacturer's schematic for visual interpretation).

3.8 MIXING OF RESIN PRODUCTS

- A. Preparation/Mixing/Catalyzing Resin Products: Pour the desired quantity of resin into a clean container and using a spiral mixer or mixing paddle, stir the liquid for the time period specified by the resin manufacturer. Calculate the amount of catalyst powder or liquid needed using the manufacturer's guidelines and add the pre-measured catalyst to the resin component. Mix again for the time period specified by the resin manufacturer, ensuring that the product is free from swirls and bubbles. To avoid aeration, do not use a spiral mixer unless the spiral section of the mixer can be fully contained in the liquid during the mixing process. Mix only enough product to ensure that it can be applied before pot life expires.
- B. Preparation/Mixing/Catalyzing Aggregate-Filled Resin Products: Pour the entire desired quantity of resin into a clean container and slowly add the pre-measured quantity of aggregate using a spiral mixer or mixing paddle, stirring the mixture for the time period specified by the resin manufacturer. Calculate the amount of catalyst powder or liquid needed using the manufacturer's guidelines and add the pre-measured catalyst to the resin/aggregate mixture. Mix again for the time period specified by the resin manufacturer, ensuring that the product is free from swirls and bubbles. To avoid aeration, do not use a spiral mixer unless the spiral section of the mixer can be fully contained in the liquid during the mixing process. Mix only enough product to ensure that it can be applied before pot life expires.

3.9 PREPARATION PASTE AND PRIMER APPLICATION

- A. Primer Application: Apply catalyzed primer resin using a roller or brush at the rate specified by the primer manufacturer over qualified and prepared substrates. Apply primer resin at the increased rate specified by the primer manufacturer over DensDeck Prime or other porous substrates. Do not

let resin pool or pond. Do not under-apply or over-apply primers as this may interfere with proper primer catalyzation. Make allowances for waste, including saturation of roller covers and application equipment.

- B. Paste Application: Apply catalyzed preparation paste using a trowel over prepared and primed substrates. Before application of any resin product over cured paste, wipe the surface of the paste using the specified cleaner/solvent and allow to dry. Treat the surface again if not followed up by resin application within 60 minutes.

3.10 FLASHING AND FIELD MEMBRANE APPLICATION

A. Base Flashing Application

1. Using masking tape, mask the perimeter of the area to receive the flashing system. Apply resin primer to substrates requiring additional preparation and allow primer to cure.
2. Pre-cut fleece to ensure a proper fit at transitions and corners prior to membrane application.
3. Apply an even, generous base coat of flashing resin to prepared surfaces using a roller at the rate specified by the resin manufacturer. Work the fleece into the wet, catalyzed resin using a brush or roller to fully embed the fleece in the resin and remove trapped air. Lap fleece layers a minimum of 2 inch (5 cm) and apply an additional coat of catalyzed resin between layers of overlapping fleece. Again using a roller, apply an even top coat of catalyzed resin immediately following embedment of the fleece at the rate specified by the resin manufacturer, ensuring that the fleece is fully saturated. Ensure that the flashing resin is applied to extend beyond the fleece (maximum ¼-inch (6 mm). Remove the tape before the catalyzed resin cures. Make allowances for waste, including saturation of roller covers and application equipment.
4. Should work be interrupted for more than 12 hours or the surface of the cured resin becomes dirty or contaminated by the elements, wipe the surface to be lapped with new flashing resin using the specified cleaner/solvent. Allow the surface to dry for a minimum 20 minutes and a maximum 60 minutes before continuing work.

B. Field Membrane Application

1. Using the specified cleaner/solvent, wipe flashing membrane surfaces to be lapped with field membrane. Allow the surface to dry for a minimum 20 minutes before continuing work.
2. Apply an even, generous base coat of field membrane resin to prepared surfaces using a roller at the rate specified by the resin manufacturer. Work the fleece into the wet, catalyzed resin using a 9-inch roller to fully embed the fleece in the resin and remove trapped air. Lap fleece layers a minimum of 2 inch (5 cm) and apply an additional coat of catalyzed resin between layers of overlapping fleece. Again using a roller, apply an even top coat of catalyzed resin immediately following embedment of the fleece at the rate specified by the resin manufacturer, ensuring that the fleece is fully saturated. Make allowances for waste, including saturation of roller covers and application equipment. Allow 2 hours cure time prior to exposing the membrane to foot traffic.

C. Color Finish Application

1. Ensure that the field and flashing membrane and has been in place for a minimum 2 hours. Using the specified cleaner/solvent, wipe field membrane surfaces to receive the color finish layer. Allow the surface to dry for a minimum 20 minutes before continuing work.

2. Apply an even top coat of catalyzed color finish resin at the rate specified by the resin manufacturer. Allow 2 hours cure time prior to exposing the membrane to foot traffic.
- 3.11 APPLICATION OF SEALANT
- A. Apply a smooth continuous bead of the specified sealant at the exposed finish ply edge transition to metal flashings incorporated into the roof system.
- 3.12 APPLICATION OF WALKTREAD
- A. Granule Anti-Skid Application: Mask the areas to receive the anti-skid system using masking tape. Apply an additional top coat of catalyzed roof resin at the rate specified by the resin manufacturer, immediately broadcast granules to refusal, and allow to cure. Remove tape before the resin cures. Allow 2 hours cure time prior to exposing the membrane to foot traffic.
 - B. Glass Bead Anti-Skid Application: Apply a layer of color finish using a prepared roof surface at the rate specified by the roofing system manufacturer. Immediately broadcast glass beads into the wet color finish using a hopper gun at the rate specified by the waterproofing system manufacturer and backroll to embed the beads.
- 3.13 FIELD QUALITY CONTROL
- A. Notify the manufacturer of job completion in order to schedule a final inspection date. Hold a meeting at the completion of the project, attended by all parties that were present at the pre-job conference. A punch list of items required for completion shall be compiled by the manufacturer's representative. Complete, sign, and send the punch list form to the manufacturer's headquarters.
 - B. Leave all areas around job site free of debris, roofing materials, equipment and related items after completion of job.
 - C. Complete all post installation procedures and meet the manufacturer's final endorsement for issuance of the specified guarantee.

END OF SECTION 07 56 00

SECTION 07 59 50 – ROOF REMOVAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- A. Uniform General Conditions, Supplementary General Conditions, Forms, applicable Specification Sections found in all other Divisions, and all Drawings apply to Work specified in this Section.

1.2 DESCRIPTION

- A. Work consists of staging, protective measures, and demolition of existing roofs, flashings, penetration flashings, insulation, and other related materials at each roof on the Electric Pump House #3, Restroom Pavilions A & B, and Pump House.
- B. All materials shall be removed to a dump site and properly disposed of with the exception of the historic clay tiles on Restroom Pavilion A which is to be salvaged for reuse.
- C. Materials removed from the roof shall be delivered to the ground via lift and bucket or via trash chute. Materials may not be thrown from the roof. Restroom Pavilion A tiles are to be removed and stockpiled for reuse.

1.3 REFERENCES

- A. Related Specification Sections
1. Section 02 42 96 – Historic Removal and Dismantling for Clay Tile Roofing salvage.
 2. Section 07 32 13 – Clay Tile Roofing
 3. Section 07 41 13 – Metal Roof Panels
 4. Section 07 52 16 – Torch-Applied Modified Bitumen Roofing
 5. Section 07 56 00 – Fluid Applied Roofing

1.4 SUBMITTALS

- A. Provide a written demolition plan outlining procedures to be employed.
- B. The demolition plan shall include the following:
1. Schedule of demolition detailed to correspond to re-roofing operations.
 2. Methods of staging with a plan showing location of dumpsters, trucks, cranes, lifts, fencing and any other elements affecting the grounds and traffic flow around the buildings.
 3. Provide a plan showing methods to be employed to maintain open fire lanes and compliance with fire department access. Coordinate with the City of San Antonio Fire Department to ensure the plan meets fire department approval prior to submitting the plan for Owner review and prior to beginning staging operations.
 4. The plan shall include a detailed description of demolition methods and procedures for trash removal from the site including identification of the dump site where materials will be deposited.
 5. The plan shall include a detailed description of how Restroom Pavilion A tiles will be removed and stored until reinstallation

1.5 JOB CONDITIONS

- A. Removal of existing roofing materials may not be undertaken during rainfall or started when rainfall is expected.
- B. Caution shall be exercised with ground equipment and containers to ensure existing paved surfaces and landscaping remain undamaged. Plywood may be placed on asphalt, concrete and/or other surfaces for protection against scarring or marking by turning wheels. Damage to paved surfaces and landscaping shall be repaired at no cost to the Owner.

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- C. Building walls, windows, etc., shall be protected from falling debris. Any damage to the building shall be repaired at no cost to the Owner.
 - D. Trash containers remaining at the site overnight shall be covered to prevent windblown debris from escaping. Debris shall be removed from the grounds surrounding the building no less than three (3) times daily including at the end of the work day. All surfaces shall be policed periodically to remove any sharp debris that may cause injury. Debris subject to wind displacement shall not be deposited above the height of the container sides.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Install temporary protection including fencing, barricades, warning lines, signs, etc.
- B. Inspect existing conditions and make arrangements for correction of deficiencies prior to beginning work.
- C. Have removal equipment, trucks and/or dumpsters in place for receipt of debris. Coordinate location of ground-based units so as to not disturb the Owner's on-going operations. No debris shall be deposited on the ground at any time.

3.2 DEMOLITION

- A. Material removal methods shall be the choice of the Contractor providing methods are industry recognized for the same or similar conditions.
- B. Roofing materials may be cut into manageable sizes prior to removal to the disposal units.
- C. Remove and discard all existing underlayment, wood decking, and roofing materials.
- D. Caution shall be exercised with insulation removal to ensure materials do not blow from the building.
- E. Materials of any kind may not be thrown from any building.
- F. Existing exposed decks shall be fully cleaned and be substantially free of old bitumen, adhesives, insulation, fasteners, etc.
- G. Concrete decking found to be wet upon exposure shall be left open as long as possible to permit drying. Locations of wet decking shall be accurately recorded on the as-built drawings.
- H. Deteriorated wood, metal or other decking materials shall be removed and replaced. Locations of deck and/or wood replacement shall be accurately recorded on the as-built drawings.
- I. Protect the clay tile to be reinstalled from damage.

3.3 CLEANING

- A. Upon completion of lifting operations immediately remove lifts and other hoisting devices.
- B. Re-open closed driveways, roads, pedestrian and other vehicular thoroughfares previously closed.
- C. Upon completion of demolition remove all temporary protection, barricades, fencing, etc. Remove trash containers and other equipment.
- D. Clean or restore building surfaces and grounds marred or affected by the work.

END OF SECTION 07 59 50

SECTION – FLASHING AND SHEET METAL

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

Uniform General Conditions, Supplementary General Conditions, Forms, applicable Specification Sections found in all other Divisions, and all Drawings apply to Work specified in this Section.

1.2 DESCRIPTION

- A. Work of this Section consists of the supply and installation of sheet metal flashings, through-wall scuppers, and diverters related to the new roofing.
- B. The Work includes removal of existing sheet metal and installation of new sheet metal incorporated into the new roof assemblies.
- C. All sheet metal work shall be warranted for five (5) years under the form found in Section 07 51 10.

1.3 REFERENCES

- A. Related Specification Sections
 - 1. Section 02 41 19 – Selective Structure Demolition
 - 2. Section 06 10 50 – Roof Carpentry
 - 3. Section 07 22 00 – Roof Insulation
 - 4. Section 07 32 13 – Clay Tile Roofing
 - 5. Section 07 41 13 – Metal Roof Panels
 - 6. Section 07 51 10 – Roofing Warranty
 - 7. Section 07 52 16 – Torch Applied Modified Bitumen Roofing
 - 8. Section 07 56 00 – Fluid Applied Roofing
- B. References and Standards
 - 1. General:
 - a. Sheet Metal and Air Conditioning Contractor’s National Association, Inc. (SMACNA) “Architectural Sheet Metal Manual” – applicable details and descriptions. The Specifications shall take precedence over any detail or process found to conflict with the SMACNA publication.
 - b. National Roofing Contractors Association (NRCA) “Roofing and Waterproofing Manual” – applicable sections. The Specifications shall take precedence over any detail or process found to conflict with the NRCA publication.
 - 2. Metal:
 - a. ASTM A-123 for hot-dipped galvanizing on steel products.
 - b. ASTM A-653 and ASTM A-653M-11 for zinc-coated galvanized steel sheet by the hot-dipped method.
 - c. Kynar 500 Prefinished Metal
 - 3. Polyurethane Sealant: ASTM C-920, Type S, Grade NS, Class 25, Use T, NT, M, A, G and O.

1.4 SUBMITTALS

- A. Submit product data for all materials proposed for installation under this Section, including but not limited to each type of sheet metal, galvanizing certification, fasteners and sealants.
- B. Submit material safety data sheets (MSDS) for sealants.
- C. Color charts and samples.
- D. Provide mock-ups per Sections 07 32 13 and 07 41 13 for review.

1.5 QUALITY ASSURANCE AND QUALIFICATIONS

- A. The installer shall be experienced in the application of this same or similar system and provide evidence of the successful completion of a minimum of five (5) projects completed within the State of Texas of the same type and be a minimum 10,000 sf roof in size.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Materials shall be delivered to the site in bundles and containers on pallets as applicable and in quantities to allow continuity of application throughout the Work. Schedule and coordinate all necessary deliveries to limit inconvenience or interruption of the Work of others and/or the Owner's continuing use of the site. All deliveries and unloading of materials shall be the sole responsibility of the Contractor. The Owner's representatives and Architect shall not be responsible or requested to assist in receipt of materials.
- B. Non-combustible materials may be stored on the roof when properly protected from damage and the elements. All materials shall be handled in a manner to preclude damage and contamination by moisture or other foreign matter.
- C. Evenly distribute materials on the roof surfaces so as to not exceed 25 pounds per square foot. Do not stack materials more than 48" high. Support sheet metal components on wood blocking above the ground or roof surface.
- D. Maintain stored sealants at Manufacturer's recommended temperatures.

1.7 JOB CONDITIONS

- A. Sheet metal and sealant work shall not be performed during precipitation or started in the event precipitation is anticipated while the building interior is exposed. The Contractor reserves the final determination as to whether to chance roofing operations when rain threatens.
- B. The Contractor shall deploy warning tape, cones and/or barricades to warn ground traffic away from where sheet metal work is being performed along the building edges.
- C. Materials shall only be applied to dry surfaces. Surfaces intended to receive the work shall be allowed to thoroughly dry before beginning work.
- D. The existing roof and flashings shall not be opened and left exposed overnight without providing temporary measures for waterproofing.

1.8 WARRANTY

- A. The Contractor shall provide a five (5) year warranty covering defects in materials and labor on the form found in Section 07 51 00 of the Specifications.
- B. Prefinished metals shall be covered by the Manufacturer's 30-year finish warranty.

PART 2 - PRODUCTS

2.1 METALS

- A. Galvanized sheet metal shall be lock-forming quality G-90 finish meeting ASTM A-653 minimum.
1. Concealed Cleats: Minimum 22-gauge. All cleats shall be continuous and be fastened in wood at 6" on center with #12 x 1.5" stainless steel pancake-head screws.
- B. Prefinished coated Metal shall be lock-forming quality 24-gauge prefinished metal or Galvalume with a fluorocarbon Kynar 500 finish or approved equal with a 30 year finish warranty. Color to be selected by Architect from Manufacturer's full range.
1. Through-wall Scupper at Electric Pump House #3: Manufactured with closure flange trim to exterior, 4 inch wide wall flanges to interior and base extending 4 inches beyond cant or tapered strip into field of roof. Stainless steel 0.019 inch sleeve No. 2B bright cold rolled unpolished.
 2. Diverters: 24 gauge
 3. Eave flashing at Pump House.
 - a. Galvalume

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- b. Extend flange onto roof at existing pitch and fasten with stainless steel nails spaced at 6" on center. Place flange beneath underlayment
- 4. Eave flashing at Restroom Pavilions A & B.
 - a. Fluorocarbon Kynar 500 or approved equal.
 - b. Extend flange onto roof at existing pitch and fasten with stainless steel nails spaced at 6" on center. Place flange beneath underlayment.
 - 5. Counterflashing and Receiver: 24-gauge. Form in shapes shown on the Drawings and as required to adequately and neatly cover the upper edge of the new roof membrane flashings as shown on the Drawings. Attach receiver to masonry or walls with masonry drive pins spaced at 16" o.c. Attach counterflashing to new receiver with #10 x 5/8" stainless steel hex-head screws spaced at 16" o.c.
- C. Stainless Steel Sheet: ASTM A666, Type [304,] conventional annealed finish, [0.018] inch thick.
 - D. Heater and other Vent Flashings: 24 gauge galvanized metal with fully soldered joints.

2.2 FASTENERS

- A. Screws: #12 x length required stainless steel screws with heads appropriate for the condition. Provide Phillips-head for all screws.
- B. Neoprene-head Screws: #12 x length required stainless steel screws with hex-head and jacketed neoprene washers.
- C. Blind Rivets: #44SS-long stainless steel blind rivets. Both mandrel and rivet shall be stainless steel.
- D. Masonry Drive Pins: 0.25" x 1.5" zinc-jacketed drive pin with galvanized pin having a Phillips-head. Equal to Powers Fasteners "Zamac Hammer-Screw".
- E. Roofing Nails: Minimum 11-gauge stainless steel ring-shank nail with 3/8" diameter head.

2.3 SEALANTS AND MISCELLANEOUS

- A. Polyurethane Sealant: Equal to Sonolastic NP-1. Polyurethane sealant shall be used where concealed only.
- B. Structural Sealant: Chem Link M-1. Structural sealant shall be used only where specific conditions are dictated by the Specifications or Drawings.
- C. Silicone Sealant: Dow Corning Clear Silicone Rubber Sealant, or clear silicone sealant as manufactured by General Electric or approved equal.
- D. Backer Rod: Closed cell foam.
- E. Primer: If necessary as recommended by Sealant Manufacturer.
- F. Lead Plumbing Vent Flashings
- G. Solder: 50/50 lead/tin solder.

PART 3 - EXECUTION

3.1 PREPARATION

- A. The Contractor shall confirm conditions at the site and advise the Architect in writing of any conditions which may adversely affect the intended installation.
- B. Work shall proceed at the appropriate time in the sequence of roofing operations. Work shall be coordinated with respect to each trade.
- C. All work shall conform to the minimum standards of SMACNA and these Specifications and the Drawings. Where a conflict exists between these standards the Contractor shall advise the Architect in writing before proceeding.

3.2 INSTALLATION, GENERAL

- A. Install sheet metal components in longest pieces possible not exceeding 10'-0".
- B. Protect metal to be exposed at all times. Dimples, unintended bends, holes and scratches may result in the component being replaced.
- C. Fasten and join metals as indicated under Part 2 above for each metal type.
- D. 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, 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 watertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture. Install concealed sealant for each joint intended to be watertight.
 - 4. Torch cutting of roof specialties is not permitted.
 - 5. Install underlayment with adhesive for temporary anchorage. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm). Roll laps of self-adhering sheet underlayment with roller; cover within 14 days.
- E. 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 [stainless-steel] roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 - 2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of [self-adhering, high-temperature sheet underlayment].
- F. Fastener Sizes: Use fasteners of sizes that will penetrate [substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance].
- G. Seal joints with sealant as required by roofing-specialty manufacturer.
- H. Seal joints as required for watertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F (4 deg C).
- I. Provide expansion and/or thermal breaks as specified and/or required.
- J. Fit all joints tightly and neatly.
- K. Neatly form and tool sealants intended to be exposed. Utilize backer rod where required by conditions where joint depth exceeds 0.5". Install primer and/or bond breaker tape as required by conditions and bonding requirements.

3.3 ROOF EDGE DRAINAGE SYSTEM INSTALLATION

- A. General: Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions.
- B. Parapet Scuppers: Install scuppers where indicated through parapet. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.

3.4 CLEANING AND PROTECTION OF FINISHED WORK

- A. Remove markings, stains and other unintended elements from all surfaces prior to Substantial Completion.
- B. Remove excess and exposed sealant at all joints unless specifically shown by the Drawings to remain exposed.
- C. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

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- D. Consult the Manufacturer of the various surfaces which may be damaged for recommended remedies and cleaning instructions. Replace any materials which cannot be cleaned to the Owner's satisfaction.
 - E. Clean and neutralize flux materials. Clean off excess solder and sealants.
 - F. Remove temporary protective coverings and strippable films as roof specialties are installed. Remove all protection elements including barricades, masking, tape, fencing, etc., prior to Substantial Completion.
 - G. Provide protection of all surfaces until the work is fully accepted by the Owner.

END OF SECTION 07 6200

SECTION 07 92 00 – JOINT SEALANTS

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 joint sealants for the applications indicated in the Joint Sealant Schedule at the end of Part 3:

1. Exterior joints in the following vertical and horizontal non-traffic surfaces:
 - a. Joints at exterior masonry and windows or doors
 - b. Perimeter joints between frames of doors, windows and louvers.
 - c. Other joints as indicated.
2. Interior joints in the following vertical and horizontal non-traffic surfaces:
 - a. Perimeter joints of exterior openings.
3. Glazing sealants
4. Existing wall penetrations, i.e. exterior electrical outlets, hose bibs, conduit and pipe penetrations, light fixtures, etc.

- B. Related Sections:

1. Division 01: Administrative, procedural, and temporary work requirements.
2. Division 07: Roofing related sealants
3. Division 08: Windows and Door sealants
4. Section 09 0391: Historic Treatment of Plain Painting
5. Historic Treatment Divisions

1.3 REFERENCES

- A. ASTM International (ASTM) (www.astm.org):

1. C510 - Standard Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants.
2. C719 - Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle).
3. C794 - Standard Test Method for Adhesion-In-Peel of Elastomeric Joint Sealants.
4. C834 - Standard Specification for Latex Sealing Compounds.
5. C920 - Standard Specification for Elastomeric Joint Sealants.
6. C1193 - Standard Guide for Use of Joint Sealants.
7. C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants.
8. C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants.
9. D2203 - Standard Test Method for Staining from Sealants.

- B. Sheet Metal and Air Conditioning Contractor's National Association, Inc. (SMACNA) "Architectural Sheet Metal Manual" – applicable details and descriptions.

1.4 SUBMITTALS

- A. Submittals for Review:

1. Product Data: Indicate sealers, primers, backup materials, bond breakers, and accessories proposed for use.
2. Samples:
 - a. 1/2 x 1/2 x 3] inch long joint sealer samples [in specified colors.

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- b. 6 inch long joint backup material samples.
 - 3. Warranty: Sample warranty form.
 - 4. Submit color charts for each sealant type for initial selection. Color may be custom.
 - 5. Submit cured color samples for each sealant type illustrating selected colors.
 - 6. Submit results of laboratory preconstruction testing.
 - 7. Submit results of field pre-construction testing.
 - B. Manufacturers Installation Instructions:
 - 1. Include instructions for removing sealants and preparing joints for new sealant.
 - C. Manufacturer's Certificate
 - 1. Certify products are suitable for intended use and products meet or exceed performance requirements. Certificate to be signed by product manufacturer.
 - D. Provide full range of color samples for Owner selection.
 - E. Installers Qualifications Data
 - F. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicate the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

1.5 QUALITY ASSURANCE

- A. Applicator Qualifications: Minimum ten (10) years [documented] experience in work of this Section. Installers performing the work shall be qualified and experienced in work of this trade and fully trained.
- B. Product Manufacturer and Suppliers: Minimum ten (10) years documented experience in the manufacture and design of the required work product.
- C. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- D. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- E. Product Testing: Obtain results for "Test Reports" paragraph in "Submittals" article from a qualified testing agency based on testing current sealant formulations within a 36-month period preceding the commencement of Work.
 - 1. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.
 - 2. Test elastomeric joint sealants according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion in peel, and indentation hardness.
- F. Laboratory Pre-Construction Testing:
 - 1. Obtain representative samples of actual substrate materials.
 - 2. Test sealers and accessories for following:
 - a. Adhesion: Test to ASTM C794 and ASTM C719; determine surface preparation and required primer.
 - b. Compatibility: Test to ASTM C1087; determine that materials in contact with sealers do not adversely affect sealant materials or sealant color.
 - c. Staining: Test to ASTM D2203, ASTM C510, or ASTM C1248; determine that sealants will not stain joint substrates.
 - d. Pre-construction testing is not required when sealant manufacturer furnishes data acceptable to Architect based on previous testing for materials matching those of this Project.
- G. Field Pre-Construction Testing: A qualified expert shall test each joint sealer and joint substrate before beginning work of this Section:
 - 1. Install sealers in mockups using joint preparation methods and materials recommended by sealer manufacturer.

2. Remove existing sealant, clean joint, and install new sealant using manufacturer's recommended joint preparation methods.
3. Install field-test joints in [location directed by Architect.]
4. Test sealers using manufacturer's standard field adhesion test; verify joint preparation and primer required to obtain optimum adhesion of sealants to joint substrate.
5. When test indicates sealant adhesion failure, modify joint preparation, primer, or both and retest until joint passes sealant adhesion test.

1.6 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or below [40] degrees F unless approved by sealer manufacturer.
 2. When joint substrates are wet or frozen.
 3. Where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
 4. Contaminates capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTIES

- A. Special Installer's Warranty: [applicator's] [10] year warranty providing coverage for [exterior] sealers and accessories that fail to provide air and watertight seal, exhibit loss of adhesion or cohesion, or do not cure.
- B. Special Manufacturer's Warranty: manufacturer's [10] year warranty providing coverage for [exterior] sealers and accessories that fail to provide air and watertight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. General: Provide 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 sealant manufacturer, based on testing and field experience.
- B. VOC Content of Interior Sealants: Provide interior sealants and sealant primers that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 1. Sealants: 250 g/L
 2. Sealants primers for Nonporous Substrates: 250 g/L
 3. Sealant primers for Porous Substrates: 775 g/L
- C. Stain-Test Response Characteristics: Where elastomeric sealants are specified to be non-staining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- D. Acceptable Manufacturers:
 1. BASF Building Systems. (www.buildingsystems.basf.com)
 2. Pecora Corp. (www.pecora.com)
 3. Sika Corp. (www.sikausa.com)
 4. Tremco, Inc. (www.tremcosealants.com)
 5. Dow Corning Corporation (www.dowcorning.com)
 6. GE Silicones (www.siliconeforbuilding.com)
 7. Painting Manufacturer's proprietary sealant compatible with paint. Refer to Section 09 9100.

8. Backer rod shall be closed cell produced or approved by the sealant Manufacturer in a size of 1.5 times that of the space being filled.
9. Sealant primer shall be produced by or approved by the sealant Manufacturer and compatible with the substrate material, i.e., concrete, aluminum, glass, over which the sealant will be applied.
10. Sealants to be compatible with Painting Manufacturer's coating

2.2 MATERIALS

A. Joint Sealer Type 1:

1. ASTM C920, Grade NS, [single] component elastomeric polyurethane type, nonstaining, tintable, non-sag.
2. Movement capability: Plus or minus [35] percent.
3. Color: To be selected from manufacturer's full color range including custom blend option. To match Painting Manufacturer's colors at windows, doors, and wood features.
4. Basis-of-Design MasterSeal NP-1 by BASF.

B. Joint Sealer Type 2:

1. ASTM C920, Grade NS, single component neutral-curing silicone type, nonstaining, tintable, non-sag.
2. Movement capability: Plus or minus 25 percent.
3. Color: To be selected from manufacturer's full color range with custom color match option.
4. Basis-of-Design Dow Corning 795 or Dow Corning 1199 by Dow Corning Corp.

C. Joint Sealer Type 3:

1. ASTM C920, Grade NS, single component butyl rubber type, non-sag.
2. Movement capability: Plus or minus 12-1/2 percent.
3. Color: To be selected from manufacturer's full color range.

D. Joint Sealer Type 4:

1. ASTM C834, single component acrylic latex, non-sag.
2. Movement capability: Plus or minus 7-1/2 percent.
3. Color: White.

E. Joint Sealer Type 5:

1. ASTM C920, Grade NS, single component silicone, non-sag, mildew resistant.
2. Movement capability: Plus or minus 50 percent.
3. Color: To be selected from manufacturer's full color range.

F. Joint Sealer Type 6:

1. ASTM C920, Grade NS, single component polyurethane type, non-sag, recommended by manufacturer for continuous water immersion.
2. Movement capability: Plus or minus 50 percent.
3. Color: To be selected from manufacturer's full color range.

2.3 ACCESSORIES

A. Primers, Bondbreakers, and Solvents: As recommended by sealer manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Joint Backing:

1. ASTM C1330, closed cell polyethylene foam, preformed round joint filler, non absorbing, non staining, resilient, compatible with sealer and primer, recommended by sealer manufacturer for each sealer type.
2. Size: Minimum 1.5 times joint width.

C. Masking Tape: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

2.4 MIXES

- A. Mix multiple component sealers in accordance with manufacturer's instructions.
 - 1. Mix with mechanical mixer; prevent air entrainment and overheating.
 - 2. Continue mixing until color is uniform.

PART 3 - EXECUTION

3.1 PREPARATION AND INSTALLATION

- 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. Remove loose and foreign matter that could impair adhesion. If surface has been subject to chemical contamination, contact sealer manufacturer for recommendation.
- D. Clean and prime joints in accordance with manufacturer's instructions.
- E. Remove the entirety of existing sealants in all the joints. Thoroughly clean each joint free of all loose and adhered materials to bare substrate such as concrete, masonry or metal.
- F. Protect adjacent surfaces with masking tape or protective coverings.
- G. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of 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.
- H. Install new backer rod at depth required by the sealant Manufacturer. The common depth shall meet a 2:1 ratio of width-to-depth. Backer rod depth shall be set by accurately gauged tools. No backer rod depth shall be determined otherwise.
- I. Install primer or bond breaker if required for proper bonding.
- J. Install new sealant at full depth and width of joint over new backer rod. Provide smooth finish fully bonded to the previously primed/prepared surfaces. Clean and remove excess sealant.
- K. Tape or other devices shall be used where joints turn vertical on the edge of sidewalks or other concrete surfaces to prevent overflow or loss of sealant. Once the sealant is set the tape shall be removed. Thoroughly clean any outflow of sealant.
- L. 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.
- M. Tooling or Non-sag Sealants: Immediately after sealant application and before skinning and curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated, to eliminate air pockets and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints. Neatly tool coved joints to achieve maximum bonding at horizontal and vertical surfaces.
 - 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 configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

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4. Provide flush joint configuration per Figure 5B in ASTM C 1193 where indicated.
 5. Provide recessed joint configuration of recess depth and at locations indicated per 5C in ASTM C 1193.
 6. Use Masking tape to protect surfaces adjacent to recessed tooled joints.
- N. Installation of Preformed tapes: Install per manufacturer's written instructions.
- O. Installation of Preformed Silicone sealant system:
1. Apply masking tape to each side of joint, outside of area to be covered by sealant system.
 2. Apply silicon sealant to each side of joint to produce a bead of size complying with preformed silicone sealant manufacturer's written instructions and covering a bonding area of not less than 3/8 inch. Hold edge of sealant bead ¼ inch inside masking tape.
 3. Within 10 minutes of sealant application, press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact between sealant and both extrusion and substrate.
 4. Complete installation of sealant system in horizontal joints before installing in vertical joints. Lap vertical joints over horizontal joints. At ends of joints, cut silicone extrusion with a razor knife.
- P. Installation of Preformed Foam Sealants: Install each length of sealant immediately after removing protective wrapping, taking care not to pull or stretch material, producing seal continuity at ends, turns, and intersection of joints. For applications at low ambient temperatures where expansion of sealant requires acceleration to produce seal, apply heat to sealant in compliance with sealant manufacturer's written instructions.
- Q. Sealer Dimensions:
1. Minimum joint size: 1/4 x 1/4 inch.
 2. Joints 1/4 to 1/2 inch wide: Depth equal to width.
 3. Joints over 1/2 inch wide: Depth equal to one half of width.

3.2 APPLICATION

- A. Apply products in accordance with manufacturer's instructions.
- B. Install sealers and accessories in accordance with ASTM C1193.
- C. Install joint backing to maintain required sealer dimensions. Compress backing approximately [25] percent without puncturing skin. Do not twist or stretch.
- D. Use bondbreaker tape where joint backing is not installed.
- E. Fill joints full without air pockets, embedded materials, ridges, and sags.
- F. At thresholds, push threshold into full bed of sealant until it oozes. Provide sufficient
- G. coverage so that when pressing threshold into sealant bed, sealant extrudes from edges and adjacent surfaces. Wipe and remove excess sealant.
- H. Tool sealer to smooth profile.
- I. Apply sealer within manufacturer's recommended temperature range.

3.3 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows;
 1. Extent of Testing: Test Completed sealant joints as follows:
 - a. Perform 2 tests for each type of sealant and joint substrate
 2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab or Method D, Water Immersions in Appendix X1 in ASTM C 1193, as appropriate for type of joint-sealant application indicated.
 - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; do this by extending cut along one side, verifying adhesion to opposite side. Repeat procedure to opposite side.
 3. Inspect joints for complete fill, for absence of voids, and for joint configuration complying with specified requirements. Record results in a field-adhesion-test log.
 4. Inspect tested joints and report on the following:
 - a. Whether sealants in joints connected to pulled out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product

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- and joint substrate. Compare these test results to determine if adhesion passes sealant manufacturer’s field-adhesion hand-pull test criteria.
 - b. Whether sealants filled joint cavities and are free of voids.
 - c. Whether sealant dimensions and configurations comply with specified requirements.
 - 5. Manufacturer to provide a letter of field test results. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
 - 6. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
 - B. Evaluation of Field Test Results: Sealants not evidencing adhesive failure from testing or non-compliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.4 CLEANING

- A. Remove masking tape and protective coverings after sealer has cured. 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 area without deterioration or damage at time of Substantial Completion. If damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT SEALANT SCHEDULE

JOINT LOCATION	SEALER TYPE	COLOR
Exterior Joints:		
Joints at window perimeter and frames	1	Match Adjacent
Door Frames at wall perimeters	1	Match Adjacent
Glazing	2	Match Adjacent
Plaster	1	Match Adjacent
Under Thresholds	1	Black
Interior Joints:		
Perimeter joints on interior side of door	1	Match Adjacent
Perimeter joints on interior side of window	1	Match Adjacent
Joints in toilet rooms at fixtures	5	

END OF SECTION 07 9200

SECTION 079201 – EXTERIOR JOINT SEALANTS

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-applied joint sealants.
 - 2. Joint-sealant backer materials.
 - 3. Primers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. Paving-Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.5 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.
 - 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 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.2 COLD-APPLIED JOINT SEALANTS (Color to match adjacent paving)

- A. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D 5893/D 5893M, Type SL.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Crafco Inc.
 - b. Pecora Corporation.
 - c. The Dow Chemical Company.
- B. Single Component, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.
- 2.3 JOINT-SEALANT FILLER AND BACKER MATERIALS
- A. Joint Fillers: ASTM D 5249, Type 2, flexible foam expansion joint in preformed strips.
 - B. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.
 - 1. Products: W.R. Meadows; Seal Tight Cermar.
- 2.4 PRIMERS
- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

- A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
- B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions.
- C. Install joint-sealant backings to support joint 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 joint-sealant backings.
 - 2. Do not stretch, twist, puncture, or tear joint-sealant backings.
 - 3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:
 - 1. Place joint sealants so they fully contact 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.

- E. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.
- 3.4 CLEANING AND PROTECTION
- A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.
 - B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

END OF SECTION

DIVISION 08

Openings

95% Construction Documents

SECTION 08 03 14 – HISTORIC TREATMENT OF WOOD DOORS

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 historic treatment of wood doors in the form of the following:
- B. Repairing wood doors and trim.
1. Replacing wood door leaves and frames.
 2. Repairing, refinishing, and replacing hardware.
- C. Related Requirements:
1. Section 01 35 91 - Historic Treatment Procedures
 2. Section 07 92 00 – Joint Sealants
 3. Section 08 11 13 - Hollow Metal Doors and Frames for replacement and new hollow metal doors not included in this Section.
 4. Section 08 71 00 - Door Hardware for repairing, refinishing, and replacing hardware.
 5. Division 9 – “Painting” for repainting historic wood and new replicated wood surfaces, including paint removal, minor patching, surface preparation for refinishing, and refinishing.

1.3 DEFINITIONS

- A. Glazing: Includes glass, glazing points, glazing tapes, glazing sealants, and glazing compounds.
- B. Door: Generally, this term includes door frame, leaves, hardware, side panels or lights, fan light, transom, storm and screen doors, and storm vestibule unless otherwise indicated by context.
- C. Wood Door Component Terminology: Wood door components for historic treatment work include the following classifications:
- D. Frame Components: Head, jambs, stop, and threshold or sill.
1. Leaf Components: Stiles, rails, and muntins.
 2. Exterior Trim: Exterior casing, brick mold, and cornice or drip cap.
 3. Interior Trim: Casing.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
1. Review minutes of Preliminary Historic Treatment Conference that pertain to historic treatment of wood doors.
 2. Review methods and procedures related to historic treatment of wood doors including, but not limited to, the following:
 - a. Historic treatment specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, material application, sequencing, tolerances, and required clearances.
 - c. Site access requirements and hours of operations.
 - d. Erection sequencing, anchoring, and safety requirements of scaffolding, lifts and hoistways, if required.
 - e. Coordination of scaffolding, lifts and hoistways access and use for all applicable rehabilitation work.
 - f. Fire-protection plan.

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- g. Wood door historic treatment program
 - h. Quality-control program.
 - i. Coordination with building occupants.
 - j. Coordination with other trades working in close proximity to historic wood doors who may impact the work, or may be impacted by the work, including shared use of scaffolding.
 - k. Review safety precautions and requirements due to unique site conditions:
 - 1) Work within and under City Public Service (CPS) utility easements.
 - 2) Potential road lane and sidewalk closures to permit erection of scaffolding.

1.5 SEQUENCING AND SCHEDULING

- A. Perform historic treatment of wood doors in the following sequence, which includes work specified in this and other Sections:
- B. Label each door frame with permanent opening-identification number in inconspicuous location.
 - 1. Tag existing door leaves and screen storm doors with opening-identification numbers and remove for on-site or off-site repair. Indicate on tags the locations on door of each component, such as "left-hand door leaf," "right-hand reverse door leaf," etc.
 - 2. Remove door, dismantle hardware, and tag hardware with door opening-identification numbers.
 - 3. In the shop, label each leaf, storm door and screen-door unit with permanent opening-identification number in inconspicuous location and remove site-applied tags.
 - 4. Install temporary protection and security at door openings.
 - 5. Sort units by condition, separating those that need extensive repair.
 - 6. Clean surfaces.
 - 7. General Wood-Repair Sequence:
- C. Remove paint to bare wood.
 - 1. Rack frames slightly to inject adhesive into mortise and tenon joints; square frames to proper fit before adhesive sets.
 - 2. Repair wood by consolidation, member replacement, partial member replacement, and patching.
 - 3. Sand, prime, fill, sand again, and prime surfaces again for refinishing.
- D. Repair, refinish, and replace hardware if required. Reinstall operating hardware.
 - 1. Install glazing.
 - 2. Remove temporary protection and security at door openings.
 - 3. Reinstall units.
 - 4. Apply finish coats.
 - 5. Install remaining hardware and weather stripping.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Include recommendations for product application and use. Include test data substantiating that products comply with requirements.
- C. Shop Drawings: For locations and extent of wood-door repair and replacement work.
- D. Include plans, elevations, sections, and details of replacement parts indicating materials, profiles, joinery, reinforcing, and method of splicing into or attaching to existing wood door, accessory items, and finishes.
 - 1. Include field-verified dimensions and the following:
- E. Full-size shapes and profiles with complete dimensions for replacement components and their jointing, showing relation of existing to new components.
 - 1. Templates and directions for installing hardware and anchorages.
 - 2. Identification of each new unit and its corresponding door locations in the building on annotated plans and elevations.
 - 3. Provisions for sealant joints and flashing as required for location.

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- F. Samples for Initial Selection: For each type of exposed wood and finish.
 - G. Identify wood species, cut, and other features.
 - 1. Include Samples of hardware and accessories involving color selection.
 - H. Samples for Verification: For the following products in manufacturer's standard sizes unless otherwise indicated, finished as required for use in the Work:
 - I. Replacement Units: 12-inch- (300-mm-) long, full-size frame and leaf sections with applied finish.
 - 1. Replacement Members: 12 inches (300 mm) long for each replacement member, including parts of frame, leaf, exterior trim, and interior trim.
 - J. Additional Samples of replacement members that show fabrication techniques, materials, and finishes as requested by Architect.
 - K. Repaired Wood Door Members: Prepare Samples using existing wood door members removed from site, repaired, and prepared for refinishing.
 - 1. Refinished Wood Door Members: Prepare Samples using existing wood door members removed from site, repaired, and refinished.
 - 2. Hardware: Full-size units with each factory-applied or restored finish.
 - 3. Weather Stripping: 12-inch- (300-mm-) long sections.
- 1.7 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For historic treatment specialist including workers and wood-repair-material manufacturer.
 - B. Wood Door Historic Treatment Program: Submit before work begins.
 - C. Preconstruction Test Reports: For historic treatment of wood doors.
- 1.8 QUALITY ASSURANCE
- A. Basis for Standard of Care: U.S. Department of the Interior – National Park Service – Standards and Guidelines for Historic Rehabilitation.
 - B. Historic Treatment Specialist Qualifications: See Section 01 3591 - Historic Treatment Procedures for general qualifications of historic treatment specialist. A qualified historic wood door specialist, experienced in repairing, refinishing, and replacing wood doors in whole and in part. Experience only in fabricating and installing new wood doors is insufficient experience for wood-door historic treatment work.
 - 1. A list of similar jobs, completed within the last three years, shall be provided. Identify when, where, and for whom the work was performed.
 - C. Wood-Repair-Material Manufacturer Qualifications: A firm regularly engaged in producing wood consolidant and wood-patching compound that have been used for similar historic wood-treatment applications with successful results, and with factory-authorized service representatives who are available for consultation and Project-site inspection and on-site assistance.
 - D. Wood Door Historic Treatment Program: Prepare a written, detailed description of materials, methods, equipment, and sequence of operations to be used for historic treatment work, including protection of surrounding materials and Project site.
 - E. If materials and methods other than those indicated are proposed for any phase of historic treatment work, add a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project.
 - F. Mockups: Prepare mockups of historic treatment repair processes to demonstrate aesthetic effects and to set quality standards for materials and execution and for fabrication and installation. Prepare mockups so they are as inconspicuous as practicable.
 - G. Locate mockups on existing wood materials where directed by Architect or locations that enable viewing under same conditions as the completed Work.
 - 1. Wood Door Repair: Prepare one entire door unit to serve as mockup to demonstrate Samples of each type of repair of wood door members including frame, leaves, glazing, and hardware.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

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3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified historic treatment specialist to perform preconstruction testing on historic wood doors.
- B. Provide test specimens representative of proposed materials and existing construction.
 1. Test historic treatment products and methods for effectiveness and compliance with specified requirements.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Pack, deliver, and store products in suitable packs, heavy-duty cartons, or wooden crates; surround with sufficient packing material to ensure that products will not be deformed, broken, or otherwise damaged.
- B. Store products inside a well-ventilated area, protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity, and where environmental conditions comply with manufacturer's requirements.

1.11 FIELD CONDITIONS

- A. Weather Limitations: Proceed with historic treatment of wood doors only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.

PART 2 - PRODUCTS

2.1 HISTORIC TREATMENT OF WOOD DOORS, GENERAL

- A. Quality Standard: Comply with applicable requirements in Section 12, "Historic Restoration Work," and related requirements in AWI/AWMAC/WI's "Architectural Woodwork Standards" for construction, finishes, grades of wood doors, and other requirements unless otherwise indicated.
- B. Exception: Industry practices cited in the "Architectural Woodwork Standards," Section 12, Article 1.5, "Industry Practices," do not apply to the work of this Section.

2.2 WOOD-BASED COMPONENTS

- A. Wood fabricated from old growth timber is not permitted.
- B. Exception: Old growth timber is permitted if wood is obtained from documented reclaimed source(s) and otherwise complies with applicable requirements.

2.3 REPLICATED WOOD DOOR UNITS

- A. Replicated Wood Door Frames and Leaves: Custom-fabricated replacement wood units and trim, with operating and latching hardware.
- B. 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:
- C. Basis of Design Manufacturers:
- D. Hallmark Cabinetry and Millwork, 326 Melrose Place, San Antonio, Texas 78212. Contact: John Hall at 210-828-8779, or;
 1. Architectural Interiors, 1350 E. Southcross Blvd., San Antonio, Texas 78223. Contact: Victor Salas at 210-319-4192.
- E. GW Cernoch Works 979-725-8975, 602 Utex Dr, Weimar, Texas 78962
- F. Barron Restorations 10509 Old Manchaca Rd, Austin, Texas 78748
- G. Red River Restorations 116 Hoxie Street, Coupland, Texas 78615
- H. Adams Architectural Millwork Co.; Subsidiary of Dubuque Sash & Door Mfg.
 1. Allegheny Restoration & Builders Inc.

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2. Architectural Components, Inc.
 3. Grabill Windows & Doors.
 4. H. Hirschmann LTD.
 5. Honeoye Falls Millwork.
 6. Kingsland Architectural Millwork.
 7. Parrett Manufacturing, Inc.
 8. Weston Millwork Company.
 9. Wewoka Window Works.
 10. Woodstone Company (The).
 11. Wood Window Workshop.
- I. Joint Construction: Joints matching existing.
- J. Wood Material:
- K. Species: White Oak, clear plain sawn with tight grain, no sap wood, and no knots permitted.
1. Moisture Content: Kiln dried with maximum moisture content of 10 to 12 percent.
 2. Basis of Design Manufacturer: Alamo Hardwoods. Contact Biff "J.R." Huebinger 210-736-3137.
- L. Wood Cut: Match cut of existing exterior wood door and frame parts.
- M. Wood Member and Trim Profiles: Match profiles and detail of existing door members and trim.
- N. Hardware: Reuse existing unless otherwise indicated in door repair schedule in drawings.
- O. Glazing Stops: Provide replacement glazing stops coordinated with glazing system indicated.
- P. Weather Stripping: Full-perimeter weather stripping for each exterior door leaf.
- Q. Date Identification: Emboss on a concealed surface of each replaced door frame and leaf, in easily read characters, "DOOR FRAME MADE 2017" or "DOOR LEAF MADE 2017." Manufacturer's name may also be embossed.

2.4 SCREEN DOORS AND GATES

- A. Repair Wood Screen Doors and Gates: Custom-fabricated repair and replacement wood components to match profiles of existing, with operating and latching hardware as scheduled.
- B. 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:
- C. Basis of Design Manufacturers:
- D. Hallmark Cabinetry and Millwork, 326 Melrose Place, San Antonio, Texas 78212. Contact: John Hall at 210-828-8779,
- E. Architectural Interiors, 1350 E. Southcross Blvd., San Antonio, Texas 78223. Contact: Victor Salas at 210-319-4192
- F. GW Cernoch Works 602 Utex Dr, Weimar, Texas 78962, 979-725-8975.
- G. Barron Restorations 11901 Johnny Weismuller Lane, Austin, Texas 78748
- H. Red River Restorations 2039 Airport Boulevard, Austin, Texas 78722
- I. Kingsland Architectural Millwork.
1. Weston Millwork Company.
 2. Woodstone Company (The).
 3. Wood Window Workshop.
- J. Joint Construction: Joints matching existing.
- K. Wood Material:
- L. Species: White Oak, clear plain sawn with tight grain, no sap wood, and no knots permitted.
1. Moisture Content: Kiln dried with maximum moisture content of 10 to 12 percent.
 2. Basis of Design Manufacturer: Alamo Hardwoods. Contact Biff "J.R." Huebinger 210-736-3137.
- M. Wood Cut: Match cut of wood primary door and frame parts.
- N. Wood Member Profiles: Match wood profiles of existing screen door.
- O. Hardware: Reuse existing unless otherwise indicated in door repair schedule on drawings.

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- P. Date Identification: If complete replacement is required, emboss on a concealed surface of each screen door, in easily read characters, "SCREEN DOOR MADE 2017." Manufacturer's name may also be embossed.

2.5 WOOD-REPLACEMENT MATERIALS

- A. Wood Material, for Frame Heads, Jambs, Exterior Trim and Leaf Components:
- B. Species: White Oak, clear plain sawn with tight grain, no sap wood, and no knots permitted.
1. Moisture Content: Kiln dried with maximum moisture content of 10 to 12 percent.
 2. Basis of Design Manufacturer: Alamo Hardwoods. Contact Biff "J.R." Huebinger 210-736-3137.
- C. Thresholds or Sills: White oak where wood thresholds exist.
- D. Astragals: Where surface mounted locks are removed from doors, replace astragal with:
1. Species: White Oak, clear plain sawn with tight grain, no sap wood, and no knots permitted at painted condition. Species and grade to match existing door at stained condition.
 2. Moisture Content: Kiln dried with maximum moisture content of 10 to 12 percent.
 3. Basis of Design Manufacturer: Alamo Hardwoods. Contact Biff "J.R." Huebinger 210-736-3137.
- E. Interior Trim: Match existing species.

2.6 WOOD-REPAIR MATERIALS

- A. Source Limitations: Obtain wood consolidant and wood-patching compound from single source from single manufacturer.
- B. Wood Consolidant: Ready-to-use product designed to penetrate, consolidate, and strengthen soft fibers of wood materials that have deteriorated because of weathering and decay and designed specifically to enhance the bond of wood-patching compound to existing wood.
- C. Products: Subject to compliance with requirements, or comparable approved product from one of the following:
- D. Basis of Design: Abatron, Inc., LiquidWood.
1. ConServ Epoxy LLC; Flexible Epoxy Consolidant 100.
 2. Gougeon Brothers, Inc.; West System.
 3. Protective Coating Company; PC-Petrifier or PC-Rot Terminator.
 4. System Three Resins, Inc.; RotFix.
- E. Wood-Patching Compound: Two-part epoxy-resin wood-patching compound; knife-grade formulation as recommended in writing by manufacturer for type of wood repair indicated, tooling time required for the detail of work, and site conditions. Compound shall be designed for filling voids in damaged wood materials that have deteriorated because of weathering and decay. Compound shall be capable of filling deep holes and spreading to feather edge.
- F. Subject to compliance with requirements, or comparable approved product from one of the following:
- G. Basis of Design Products: Abatron, Inc; LiquidWood with WoodEpoxy
1. Advanced Repair Technology, Inc.; Primatrate with Flex-Tec HV.
 2. ConServ Epoxy LLC; Flexible Epoxy Consolidant 100 with Flexible Epoxy Patch 200.
 3. Gougeon Brothers, Inc.; West System thickened with filler.
 4. Polymeric Systems, Inc.; QuickWood.
 5. Protective Coating Company; PC-Woody.
 6. System Three Resins, Inc.; Sculpwood.

2.7 GLAZING MATERIALS

- A. Glass: Salvage and reuse historic glass where permitted by the building code including untouched panes. Otherwise, provide and install tempered and safety glazing where the panes meet the criteria of Chapter 24 of the 2021 International Building Code.
- B. Glazing Systems: Refer to Section 07 9200 Joint Sealants.
1. Primers and Cleaners for Glazing: As recommended in writing by glazing material manufacturer.

2.8 HARDWARE

- A. Primary Door Hardware, General: Provide complete sets of door hardware consisting of hinges, pulls, locks, latches, and accessories indicated for each door or required for proper operation. Sets shall include replacement hardware to complement repaired and refinished, existing hardware. Door hardware shall smoothly operate, tightly close, and securely lock wood doors and be sized to accommodate frequency of use, glazing weight, and dimensions. Refer to Section 08 7100.
- B. Other Hardware, General: Provide complete sets of hardware for each type of screen door consisting of hinges, pulls, latches, fasteners, clips, and accessories indicated or required for proper operation. Hardware shall smoothly operate, tightly close, and secure units appropriately for frequency of use, unit weight, and dimensions. Refer to Section 08 7100.
- C. Replacement Hardware: Refer to Section 08 7100. Replacement intent of missing historic door knobs, levers, escutcheons, latches, handles or pulls at the first floor is to first locate similar hardware on the second floor and relocate it at the first floor, with the first floor doors being the priority for complete historic knobs, levers or pulls placement. Replace the balance of the existing damaged or missing knobs, pulls, handles or levers with new hardware manufactured by one of the following:
 - 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. Architectural Resource Center (The).
 - b. Ball and Ball.
 - c. Blaine Window Hardware Inc
- D. Hardware Finishes: Comply with BHMA A156.18 for base material and finish requirements indicated by the following:
 - 1. BHMA 613: Dark-oxidized satin bronze, oil rubbed, bronze base metal.

2.9 WEATHER STRIPPING

- A. Refer to Section 08 71 00.

2.10 MISCELLANEOUS MATERIALS

- A. Borate Preservative Treatment: Inorganic, borate-based solution, with disodium octaborate tetrahydrate as the primary ingredient; manufactured for preserving weathered and decayed wood from further damage by decay fungi and wood-boring insects; complying with AWPA P5; containing no boric acid. Confirm compatibility with screen mesh.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Abatron, Inc. product, or comparable product by one of the following:
 - 2. Nisus Corporation.
 - 3. System Three Resins, Inc.
- B. Cleaning Materials:
 - 1. Detergent Solution: Solution prepared by mixing 2 cups (0.5 L) of tetrasodium pyrophosphate (TSPP), 1/2 cup (125 mL) of laundry detergent that contains no ammonia, 5 quarts (5 L) of 5 percent sodium hypochlorite bleach, and 15 quarts (15 L) of warm water for each 5 gal. (20 L) of solution required.
 - 2. Mildewcide: Commercial, proprietary mildewcide or a solution prepared by mixing 1/3 cup (80 mL) of household detergent that contains no ammonia, 1 quart (1 L) of 5 percent sodium hypochlorite bleach, and 3 quarts (3 L) of warm water.
 - 3. Adhesives: Wood adhesives with minimum 15- to 45-minute cure at 70 deg F (21 deg C), in gunnable and liquid formulations as recommended in writing by adhesive manufacturer for each type of repair and exposure conditions.
- C. Fasteners: Use fastener metals that are noncorrosive and compatible with each material joined.
- D. Match existing fasteners in material and type of fastener unless otherwise indicated.
 - 1. Use concealed fasteners for interconnecting wood components.

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2. Use concealed fasteners for attaching items to other work unless exposed fasteners are unavoidable or the existing fastening method.
 3. For fastening metals, use fasteners of same basic metal as fastened metal unless otherwise indicated.
 4. For exposed fasteners, use Phillips-type machine screws of head profile flush with metal surface unless otherwise indicated.
 5. Finish exposed fasteners to match finish of metal fastened unless otherwise indicated.
- E. Anchors, Clips, and Accessories: Fabricate anchors, clips, and door accessories of aluminum, nonmagnetic stainless steel, or hot-dip zinc-coated steel complying with requirements in ASTM B 633 for SC 3 (Severe) service condition.

2.11 WOOD DOOR FINISHES

- A. Refer to Section 09 9100 Painting and Staining

PART 3 - EXECUTION

3.1 HISTORIC TREATMENT SPECIALIST

- A. Historic Treatment Specialist Firms: Subject to compliance with requirements, firms that may provide historic treatment of wood doors include, but are not limited to, the following:
1. Hallmark Cabinetry and Millwork, 326 Melrose Place, San Antonio, Texas 78212. Contact: John Hall at 210-828-8779.
 2. Architectural Interiors, 1350 E. Southcross Blvd., San Antonio, Texas 78223. Contact: Victor Salas at 210-319-4192.
 3. GW Cernoch Works 979-725-8975, 602 Utex Dr, Weimar, Texas 78962
 4. Barron Restorations 10509 Old Manchaca Rd, Austin, Texas 78748
 5. Red River Restorations 116 Hoxie Street, Coupland, Austin, Texas 78615

3.2 PREPARATION

- A. Protect adjacent materials from damage by historic treatment of wood doors.
- B. Clean wood doors of mildew, algae, moss, plant material, loose paint, grease, dirt, and other debris by scrubbing with bristle brush or sponge and detergent solution. Scrub mildewed areas with mildewcide. After cleaning, rinse thoroughly with fresh water. Allow to dry before repairing or painting.
- C. Condition replacement wood members and replacement units to prevailing conditions at installation areas before installing.

3.3 HISTORIC TREATMENT OF WOOD DOORS, GENERAL

- A. Historic Treatment Appearance Standard: Completed work is to have a uniform appearance as viewed by Architect from the door interior at 5 feet (1.5 m) away and from the door exterior at 10 feet (6 m) away.
- B. General: In treating historic items, disturb them as minimally as possible and as follows:
- C. Stabilize and repair wood doors to reestablish structural integrity and weather resistance while maintaining the existing form of each item.
1. Remove coatings and apply borate preservative treatment before repair. Remove coatings according to Section 09 0391 "Historic Treatment of Plain Painting" unless otherwise indicated.
 2. Repair items in place where possible.
 3. Install temporary protective measures to protect wood door work that is indicated to be completed later.
 4. Refinish historic wood windows according to Section 09 0391 "Historic Treatment of Plain Painting" unless otherwise indicated.

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- D. Mechanical Abrasion: Where mechanical abrasion is needed for the work, use only the gentlest mechanical methods, such as scraping and natural-fiber bristle brushing, that will not abrade wood substrate, reducing clarity of detail. Do not use abrasive methods such as sanding, wire brushing, or power tools except as indicated as part of the historic treatment program and as approved by Architect.
 - E. Repair and Refinish Existing Hardware: Dismantle door hardware; strip paint, repair, and refinish it to match finish Samples; and lubricate moving parts just enough to function smoothly.
 - F. Repair Wood Doors: Match existing materials and features, retaining as much original material as possible to perform repairs.
 - G. Unless otherwise indicated, repair wood doors by consolidating, patching, splicing, or otherwise reinforcing wood with new wood matching existing wood or with salvaged, sound, original wood.
 - 1. Where indicated, repair wood doors by limited replacement matching existing material.
 - H. Replace Wood Units: Where indicated, duplicate and replace units with units made from salvaged, sound, original wood or with new wood matching existing wood. Use surviving prototypes to create patterns for duplicate replacements.
 - I. Do not use substitute materials unless otherwise indicated.
 - 1. Compatible substitute materials may be used.
 - J. Protection of Openings: Where doors are indicated for removal, cover resultant openings with temporary enclosures so that openings are weathertight during repair period.
 - K. Identify removed doors, frames, leaves, and members with numbering system corresponding to door locations to ensure reinstallation in same location. Key doors, leaves, and members to Drawings showing location of each removed unit. Permanently label units in a location that will be concealed after reinstallation.

3.4 WOOD DOOR PATCH-TYPE REPAIR

- A. General: Patch wood members that exhibit depressions, holes, or similar voids and that have limited amounts of rotted or decayed wood.
- B. Remove leaves and screen doors from door frames before performing patch-type repairs at meeting or sliding surfaces unless otherwise indicated. Reglaze units prior to reinstallation.
 - 1. Verify that surfaces are sufficiently clean and free of paint residue before patching.
 - 2. Treat wood members with wood consolidant before applying patching compound. Coat wood surfaces by brushing, applying multiple coats until wood is saturated and unable to absorb more. Allow treatment to harden before filling void with patching compound.
 - 3. Remove rotted or decayed wood down to sound wood.
- C. Apply borate preservative treatment to accessible surfaces either before applying wood consolidant or after removing rotted or decayed wood. Apply treatment liberally by brush to joints, edges, and ends; top, sides, and bottom. Allow treatment to dry.
- D. Apply wood-patching compound to fill depressions, nicks, cracks, and other voids created by removed or missing wood.
- E. Prime patch area with application of wood consolidant or manufacturer's recommended primer.
 - 1. Mix only as much patching compound as can be applied according to manufacturer's written instructions.
 - 2. Apply patching compound in layers as recommended in writing by manufacturer until the void is completely filled.
 - 3. Sand patch surface smooth and flush with adjacent wood, without voids in patch material, and matching contour of wood member.
 - 4. Clean spilled compound from adjacent materials immediately.

3.5 WOOD DOOR MEMBER-REPLACEMENT REPAIR

- A. General: Replace parts of or entire wood door members at locations indicated on Drawings or where damage is too extensive to patch.

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- B. Remove leaves and screen doors from doors before performing member-replacement repairs unless otherwise indicated.
 - 1. Verify that surfaces are sufficiently clean and free of paint residue before repair.
 - 2. Remove broken, rotted, and decayed wood down to sound wood.
 - 3. Custom fabricate new wood to replace missing wood; either replace entire wood member or splice new wood part into existing member.
 - 4. Secure new wood using finger joints, multiple dowels, or splines with adhesive and nailing to ensure maximum structural integrity at each splice. Use only concealed fasteners. Fill nail holes and patch surface to match surrounding sound wood.
 - C. Apply borate preservative treatment to accessible surfaces after replacements are made. Apply treatment liberally by brush to joints, edges, and ends; top, sides, and bottom.
 - D. Repair remaining depressions, holes, or similar voids with patch-type repairs.
 - E. Clean spilled materials from adjacent surfaces immediately.
 - F. Glazing: Reglaze units before reinstallation.
 - G. Mill new and rout existing glazed members to accommodate new glass thickness.
 - 1. Provide replacement glazing stops coordinated with glazing system indicated.
 - 2. Provide glazing stops to match contour of door frames.
 - H. Reinstall units removed for repair into original openings.
 - I. Weather Stripping: Replace nonfunctioning and install missing weather stripping to ensure full-perimeter weather stripping for each exterior leaf.

3.6 GLAZING

- A. Remove existing glass and glazing where indicated on the drawings or where damage is too extensive to repair, and prepare surfaces for reglazing.
- B. Comply with combined written instructions of manufacturers of replacement glass, glazing system, and glazing materials, unless more stringent requirements are indicated.
- C. Remove cracked and damaged glass and glazing materials from openings and prepare surfaces for reglazing.
- D. Remove glass and glazing from openings and prepare surfaces for reglazing.
- E. Size glass as required by Project conditions to provide necessary bite on glass, minimum edge and face clearances, with reasonable tolerances.
- F. Apply primers to joint surfaces where required for adhesion of glazing system, as determined by preconstruction testing.
- G. Install setting bead, side beads, and back bead against stop in glazing rabbets before setting glass.
- H. Install glass with proper orientation so that coatings, if any, face exterior or interior as required.
- I. Install glazing.

3.7 WOOD DOOR UNIT REPLACEMENT

- A. General: Replace existing wood door frame, leaf, and screen door units with new custom-fabricated units to match existing at locations indicated on Drawings or where damage is too extensive to repair.
- B. Apply borate preservative treatment to accessible surfaces before finishing. Apply treatment liberally by brush to joints, edges, and ends; top, sides, and bottom.
- C. Mill glazed members to accommodate glass thickness. Glaze units before installation.
- D. Install units, hardware, weather stripping, accessories, and other components as indicated on Drawings or where damage is too extensive to repair.
- E. Install units level, plumb, square, true to line, without distortion or impeding movement, anchored securely in place to structural support, and in proper relation to wall flashing, trim, and other adjacent construction.
- F. Set threshold or sill members in bed of sealant for weathertight construction unless otherwise indicated.
- G. Install door units with new anchors into existing openings.
- H. Weather Stripping: Install full-perimeter weather stripping for each operable exterior leaf.

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- I. Metal Protection: Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.
 - J. Disposal of Removed Units: Deliver as salvage to Owner for storage where directed.
- 3.8 WEATHER STRIPPING INSTALLATION
- A. Install weather stripping for tight seal of joints as determined by preconstruction testing and demonstrated in mockup.
- 3.9 FIELD QUALITY CONTROL
- A. Manufacturers Field Service: Engage a factory-authorized, wood-repair-material service representative for consultation and Project-site inspection and to provide on-site assistance when requested by Architect.
- 3.10 ADJUSTING
- A. Adjust existing and replacement operating leaves, screens, hardware, weather stripping, and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.
- 3.11 CLEANING AND PROTECTION
- A. Protect door surfaces from contact with contaminating substances resulting from construction operations. Monitor door surfaces adjacent to and below exterior concrete and masonry during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances contact door surfaces, remove contaminants immediately.
 - B. Clean exposed surfaces immediately after historic treatment of wood doors. Avoid damage to coatings and finishes. Remove excess sealants, glazing and patching materials, dirt, and other substances.
 - C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
- 3.12 HISTORIC DOOR SCHEDULE
- A. Refer to Drawing Sheets H0.01 (Pump House), H5.01 (Pavilion A) and H5.01 (Pavilion B) for Historic Door Schedule.

END OF SECTION 08 03 14

SECTION 08 03 51 – HISTORIC TREATMENT OF STEEL WINDOWS

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 historic treatment of steel windows in the form of the following:
1. Repairing steel windows and trim.
 2. Reglazing.
 3. Repairing, refinishing, and replacing hardware.
- B. Related Requirements:
1. Section 01 35 91 - Historic Treatment Procedures for general historic treatment requirements.
 2. Section 02 42 96 - Historic Removal and Dismantling for historic removal and dismantling work.
 3. Section 07 92 00 – Joint Sealants.

1.3 DEFINITIONS

- A. Glazing: Includes glass, glazing clips, glazing tapes, glazing sealants, and glazing compounds.
- B. Window: Includes window frame, sash, hardware, and insect screens unless otherwise indicated by context.
- C. Steel Window Component Terminology: Steel window components for historic treatment work are welded together from steel shapes and include the following classifications:
1. Subframe: Steel anchorage, usually built into wall construction.
 2. Window-Frame Members: Head, jambs, and sill.
 3. Sash Members: Stiles, rails, and muntins.
 4. Hardware: Sash handles, sash locks, and operable awning hinges.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference on historic treatment of steel windows at Project site.
1. Review minutes of Preliminary Historic Treatment Conference that pertain to historic treatment of steel windows.
 2. Review methods and procedures related to historic treatment of steel windows, including, but not limited to, the following:
 - a. Historic treatment specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, salvage materials, material application, sequencing, tolerances, and required clearances.
 - c. Fire-protection plan.
 - d. Steel window historic treatment program.
 - e. Coordination with building occupants.
 - f. Coordination with other trades working in close proximity to historic steel windows who may impact the work, or may be impacted by the work, including shared use of scaffolding.
 - g. Review safety precautions and requirements due to unique site conditions:
 - 1) Work within and under City Public Service (CPS) utility easements;
 - 2) Potential road lane and sidewalk closures to permit erection of scaffolding

1.5 SEQUENCING AND SCHEDULING

- A. Perform historic treatment of steel windows in the following sequence, which includes work specified in this and other Sections:
1. Label each window frame with permanent opening-identification number in inconspicuous location.
 2. Tag existing window sash and detachable insect screens with opening-identification numbers.
 3. Remove window sash, dismantle hardware, and tag hardware with opening-identification numbers.
 4. Remove window frames, if required due to severe deterioration that prevents in-place historic treatment, and tag with opening-identification numbers.
 5. Remove caulking and sealant residue from perimeter masonry and concrete.
 6. Dismantle unused window accessory hardware from masonry or concrete and repair holes according to requirements in other Sections.
 7. Frame and Subframe Repair Sequence:
 - a. Remove rust and paint to bare steel. Prime immediately. Verify and strip lead-based paint according to regulatory requirements.
 - b. Align and straighten frame and subframe to close completely and fit snugly around entire perimeter of frame and sash.
 - c. Repair steel by patching or removing severely corroded areas and welding or brazing steel of matching cross section. Spot prime immediately.
 - d. Extract corroded anchor fasteners from surrounding historic masonry wall and cast-in-place concrete structure and replace with new stainless steel anchor fasteners and epoxy adhesive.
 - 1) Extract and immediately replace each existing anchor fastener individually to ensure frame and subframe remain securely always anchored in wall during the historic treatment.
 - 2) Proceed in a criss-cross fashion with extraction and replacement of anchor fasteners around the perimeter of the frame until all existing fasteners have been replaced.
 - 3) If an existing anchor fastener cannot be extracted or drilled out of the frame and subframe, retain in place to avoid damaging the window frame or adjacent historic materials. Drill new hole in frame and subframe located a minimum of 1" and a maximum of 3" from existing anchor, and install new stainless steel anchor fasteners and epoxy adhesive.
 8. Install temporary protection and security at window openings.
 9. In the shop, label each removed item with permanent opening-identification number in inconspicuous location and remove site-applied tags.
 10. Sort units by condition, separating those that need extensive repair.
 11. Clean surfaces.
 12. General Steel-Repair Sequence:
 - a. Remove rust and paint to bare steel. Prime immediately. Verify and strip lead-based paint according to regulatory requirements.
 - b. Align and straighten sash and frame to close completely and fit snugly around entire perimeter of sash.
 - c. Repair steel by patching or removing severely corroded areas and welding or brazing steel of matching cross section. Spot prime immediately.
 - d. If thicker-than-original glass is required, provide modified glazing clips to secure glass.
 13. Repair and refinish hardware; replace missing hardware.
 14. Apply second coat of primer on surfaces that will be concealed when window is reinstalled.
 15. Remove temporary protection and security at window openings.

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16. Reinstall and adjust units.
 17. Install glazing.
 18. Apply finish coats.
 19. Install hardware.
 20. Install weather stripping if any..
 21. Seal perimeter joints between frames and masonry or concrete according to requirements in other Sections.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include recommendations for product application and use.
- B. Shop Drawings: Include plans, elevations, and sections showing locations and extent of repair and replacement work, with enlarged details of replacement parts indicating materials, profiles, connections, reinforcing, method of splicing into or attaching to existing steel window, accessory items, and finishes. Include field-verified dimensions and the following:
 1. Schedule of window and sash repairs, using same reference number for openings as those on Contract Drawings.
 2. Full-size shapes and profiles with complete dimensions for replacement components and their connections, showing relationship of existing components to new components.
 3. Details of temporary protection and security at window openings.
 4. Templates and directions for installing storm windows if any.
 5. Identification of each new unit and its corresponding window locations in the building on annotated plans and elevations.
 6. Hardware schedule using same reference numbers for openings.
 7. Provisions for sealant joints, flashing and safety glass as required for location.
 8. Include Samples of hardware and accessories involving color selection.
- C. Samples for Verification: For the following products in manufacturer's standard sizes unless otherwise indicated, finished as required for use in the Work:
 1. Replacement Units: 12-inch-long, full-size frame mullion and sash sections with shop-applied finish.
 2. Repaired Steel Window Members: Prepare Samples using steel window members from salvage sources, repaired and prepared for refinishing.
 - a. Additional Samples that show welding or brazing techniques, materials, and finishes as requested by Architect.
 3. Refinished Steel Window Members: Prepare Samples using steel window members from salvage sources, repaired and refinished.
 4. Hardware: Full-size units with each shop-applied or restored finish.
 5. Weather Stripping: 12-inch- long section of mated steel members with weather stripping.
 6. Glass: Full-size units of each type and appearance.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For historic treatment specialist and steel-repair-material manufacturer.
- B. Steel Window Historic Treatment Program: Submit before work begins.

1.8 QUALITY ASSURANCE

- A. Basis for Standard of Care: U.S. Department of the Interior – National Park Service – Standards and Guidelines for Historic Rehabilitation.
- B. Historic Treatment Specialist Qualifications: A qualified historic steel window specialist, experienced in repairing, refinishing, and replacing steel windows in whole and in part. Experience only in fabricating and installing new steel windows is insufficient experience for steel window historic treatment work.

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- C. Steel-Patching-Compound Manufacturer Qualifications: A firm regularly engaged in producing steel-patching compound that has been used for similar historic-metal-repair applications with successful results.
 - D. Steel Window Historic Treatment Program: Prepare a written, detailed description of materials, methods, equipment, and sequence of operations to be used for historic treatment work, including protection of surrounding materials and Project site.
 - 1. If materials and methods other than those indicated are proposed for any phase of historic treatment work, add a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project.
 - E. Mockups: Prepare mockups of historic treatment repair processes to demonstrate aesthetic effects and to set quality standards for materials and execution, and for fabrication and installation. Prepare mockups so they are as inconspicuous as practicable.
 - 1. Locate mockups on existing windows where directed by Architect.
 - 2. Steel Window Repair: Prepare one entire window unit to serve as mockup to demonstrate samples of each type of repair of steel window members, including frame, sash, glazing, and hardware.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- 1.9 DELIVERY, STORAGE, AND HANDLING
- A. Pack, deliver, and store products in suitable packs, heavy-duty cartons, or wooden crates; surround with sufficient packing material to ensure that products will not be deformed, broken, or otherwise damaged.
 - B. Store products inside a well-ventilated area and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity, and where environmental conditions comply with manufacturer's requirements.
- 1.10 FIELD CONDITIONS
- A. Weather Limitations: Proceed with historic treatment of steel windows only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.

PART 2 - PRODUCTS

- 2.1 REPLICATED STEEL WINDOW UNITS
- A. Replicated steel window units may only be utilized if an historic unit is identified by Architect as missing or beyond repair. Initial condition assessment of existing historic steel units did not identify units missing or beyond repair. The following paragraph is for contingent purposes should a unit be deemed irreparable during historic treatment.
 - B. Replicated Steel Window Frames and Sash: Replacement, welded-steel units matching existing units; custom fabricated from salvaged windows, new steel shapes, or a combination thereof; and with operating and latching hardware.
 - 1. Manufacturers: Subject to compliance with requirements, provide products fabricated by the historic treatment specialist firms.
 - 2. Steel Window Members: Match profiles and detail of existing window members.
 - 3. Exposed Hardware: Match existing exposed window hardware.
 - 4. Weather Stripping: Full-perimeter weather stripping for each operable sash.

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5. Date Identification: Emboss on a concealed surface of each replaced window frame and sash, in easily read characters, "WINDOW MADE 2023" or "SASH MADE 2023." Manufacturer's name may also be embossed.

2.2 STEEL-REPAIR MATERIALS

- A. Steel: Steel shapes from the following: Use available salvage sources before using new steel materials.
 1. Salvage Sources: Sound steel with no rust or only surface rust, straight, and with cross-sectional shapes matching existing steel shapes.
 2. New Steel Plate, Shapes, and Bars: ASTM A 36/A 36M.
- B. Steel-Patching Compound: Two-part, metal-filled epoxy resin, steel-patching compound; knife-grade formulation as recommended in writing by manufacturer for types of repair indicated, tooling time required for the detail of work, and site conditions. Compound shall be produced for filling metal that has deteriorated due to corrosion. Filler shall be capable of filling deep holes and spreading to featheredge.
 1. Source Limitations: Obtain steel-patching compound from single source from single manufacturer.
 2. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ITW Devcon; Plastic Steel Putty.
 - b. Belzona, Inc., subsidiary of Belzona International, Ltd.; Belzona 111 (Super Metal).
 - c. Approved equal.

2.3 GLAZING MATERIALS

- A. Glass: Low-emissivity coated clear laminated glass with two float-glass plies of 3.0 mm and an interlayer thickness of 0.030 inch (0.76 mm) units.
- B. Glazing Systems:
 1. Traditional Glazing Products: Glazing clips and oil-based glazing putty compound, struck uniformly to match taper of existing glazing putty (removed); colored as required to match painted sash.
 - a. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) DAP Products Inc.; DAP 33 Glazing.
 - 2) Sarco Putty Company, Inc.; SarcoSeal Dual Glaze Elastic Glazing Compound.
 - 3) Approved equal.
 2. Modern Glazing Products: Glazing clips and single-component polyurethane glazing compound; ASTM C 920, Type S, Grade NS, Class 25, Use G; applied as a thin bead between the interior face of glass and metal sash frame to retain glass and reduce air and water infiltration.
 3. Primers and Cleaners for Glazing: As recommended in writing by glazing material manufacturer.

2.4 HARDWARE

- A. Window Hardware: Provide complete sets of window hardware consisting of hinges, pulls, latches, and accessories indicated for each window or required for proper operation. Sets shall include replacement hardware to complement repaired and refinished existing hardware. Window hardware shall smoothly operate, tightly close, and securely lock steel windows and be sized to accommodate sash weight and dimensions.
- B. Replacement Hardware: Replace existing damaged or missing hardware with hardware from salvage sources or newly manufactured hardware.

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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. Blaine Window Hardware Inc.
 - b. Bronze Craft Corporation (The).

 - C. Material and Design:
 1. Material: Nonmagnetic stainless steel unless otherwise indicated.
 2. Design: Match type and appearance of existing hardware.
 3. Replacement Window Hardware: Match existing window hardware of the following types:
 - a. Awning window hinges.
 - b. Window latch.
 - c. Handle.

 - D. Hardware Finishes: Comply with BHMA A156.18 for base material and finish requirements indicated by the following:
 1. BHMA 613: Dark-oxidized satin bronze, oil-rubbed; bronze base metal.
 2. BHMA 631: Flat Black coated
 3. To be coordinated and compatible with existing element finishes.
- 2.5 WEATHER STRIPPING MATERIALS
- A. Sealant: Multicomponent, nonsag, neutral-curing silicone joint sealant; ASTM C 920, Type M, Grade NS, for Use NT; color to match window frame.
 - B. Bond-Breaker Strip: Polyethylene tape or other plastic tape to which sealant does not adhere, as recommended in writing by sealant manufacturer; width as required to fully cover mating joint between sash and frame.
- 2.6 MISCELLANEOUS MATERIALS
- A. Detergent Solution: Solution prepared by mixing 2 cups (0.5 L) of tetrasodium pyrophosphate (TSPP), 1/2 cup (125 mL) of laundry detergent that contains no ammonia, 5 quarts (5 L) of 5 percent sodium hypochlorite bleach, and 15 quarts (15 L) of warm water for each 5 gal. (20 L) of solution required.
 - B. Rust Remover: Manufacturer's standard phosphoric acid-based gel formulation, also called "naval jelly," for removing corrosion from iron and steel.
 - C. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer according to [MPI #23 (surface-tolerant, anti-corrosive metal primer)] [or] [SSPC-Paint 20 or SSPC-Paint 29].
 1. Surface Preparation: Use coating requiring no better than [SSPC-SP 2, "Hand Tool Cleaning"] [SSPC-SP 3, "Power Tool Cleaning"] [or] [SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning"].
 2. VOC Limit: Use coating with a VOC content of 400 g/L (3.3 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - D. Fasteners: Use fastener metals that are noncorrosive and compatible with each material joined.
 1. Match existing fasteners in material and type unless otherwise indicated.
 2. Use concealed fasteners to attach items to other work unless exposed fasteners are unavoidable or the existing fastening method.
 3. For fastening metals, use fasteners of same basic metal as fastened metal unless otherwise indicated.
 4. For exposed fasteners, use Phillips-type or Hexagon Socket-type machine screws of head profile flush with metal surface unless otherwise indicated.
 5. Finish exposed fasteners to match finish of metal fastened unless otherwise indicated.
 - E. Anchors, Clips, and Accessories: Fabricate anchors, clips, and window accessories of nonmagnetic stainless steel or hot-dip zinc-coated steel complying with requirements in ASTM B 633 for SC 3 (Severe) service condition.

2.7 STEEL WINDOW FINISHES

- A. Shop-Primed Replacement Units: Manufacturer's standard shop-prime coat on exposed surfaces; compatible with indicated finish coating.
- B. Retain "Site-Finished Units" Paragraph below if site-finished replacement window frames or sash are required. Copy paragraph and revise for multiple finishes on the same project; indicate locations of each on Drawings or by inserts.
- C. Site-Finished Units: [High-performance, pigmented polyurethane-over-epoxy system] [Alkyd] [Latex] <Insert system type> finish system consisting of [primer and two finish coats] <Insert requirement> on exposed exterior and interior surfaces.
 - 1. Finish Coats: [Manufacturer's standard.] [Match intermediate coat and topcoat products used for adjacent, repaired steel windows, as specified in Section 090391 "Historic Treatment of Plain Painting."] <Insert requirement>.
- D. Retain "Shop-Finished Units" Paragraph below if shop-finished replacement window frames or sash are required. Copy paragraph and revise for multiple finishes on the same project; indicate locations of each on Drawings or by inserts.
- E. Shop-Finished Units: [Baked-enamel or powder-coated] [High-performance, pigmented polyurethane-over-epoxy system] [Alkyd] [Latex] <Insert system type> finish system consisting of [primer and two finish coats] <Insert requirement> on exposed exterior and interior surfaces.
 - 1. Finish Coats: [Manufacturer's standard.] [Match intermediate coat and topcoat products used for adjacent, repaired steel windows, as specified in Section 090391 "Historic Treatment of Plain Painting."] <Insert requirement>.
- F. Munsell Color and Plochere Color System numbers in "Color and Gloss" Paragraph below are examples only. Munsell Color and Plochere Color Systems are discussed in the Evaluations in Section 090391 "Historic Treatment of Plain Painting."
- G. Color and Gloss: Match [Munsell Color 10 G 8/2] [Plochere Color System #8da399] [colors indicated on Historic Structure Report] [colors indicated on Drawings] <Insert color(s) or requirement>.

PART 3 - EXECUTION

3.1 HISTORIC TREATMENT SPECIALIST

- A. Historic Treatment Specialist Firms: Subject to compliance with requirements, firms that may provide historic treatment of steel windows include, but are not limited to, the following:
 - 1. Hallmark Cabinetry and Millwork, 326 Melrose Place, San Antonio, Texas 78212. Contact: John Hall at 210-828-8779.
 - 2. Architectural Interiors, 1350 E. Southcross Blvd., San Antonio, Texas 78223. Contact: Victor Salas at 210-319-4192.
 - 3. Red River Restorations, 116 Hoxie Street, Coupland, Texas 78615 Contact: Katie Hindman at 512.998-3432
 - 4. Barron Restorations, 10509 Old Manchaca Rd, Austin, Texas 78748, 214-810-0232

3.2 PREPARATION

- A. Protect adjacent materials from damage by historic treatment of steel windows.
- B. Clean steel windows of mildew, algae, moss, plant material, loose paint, grease, dirt, and other debris by scrubbing with bristle brush or sponge and detergent solution. After cleaning, rinse thoroughly with fresh water. Allow to dry before repairing or painting.

3.3 HISTORIC TREATMENT OF STEEL WINDOWS, GENERAL

- A. Historic Treatment Appearance Standard: Completed work is to have a uniform appearance as viewed by Architect from the window interior at 5 feet (1.5 m) away and from the window exterior at 20 feet (6 m) away.
- B. General: In treating historic items, disturb them as minimally as possible and as follows:

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1. Stabilize and repair steel windows to reestablish structural integrity and weather resistance while maintaining the existing form of each item.
 2. Remove coatings from accessible surfaces according to Section 090391 "Historic Treatment of Plain Painting" unless otherwise indicated.
 3. Repair items in place where possible, unless otherwise indicated.
 4. Repaint historic steel windows according to Section 090391 "Historic Treatment of Plain Painting" unless otherwise indicated.
- C. Mechanical Abrasion: Do not use abrasive methods, such as sanding, wire brushing, or power tools, except as indicated as part of the historic treatment program and as approved by Architect.
- D. Repair and Refinish Existing Hardware: Dismantle window hardware; strip paint, repair, and refinish it to match finish samples; and lubricate moving parts just enough to function smoothly.
- E. Repair Steel Windows: Match existing materials and features, retaining as much original material as possible to perform repairs.
1. Unless otherwise indicated, repair steel windows by patching, splicing, or otherwise reinforcing steel with new or salvaged steel members.
 2. Where indicated, repair steel windows by limited replacement matching existing material.
- F. Replace Steel Units: Where indicated, duplicate and replace units with units made from salvaged, sound, steel windows and their components or with new steel shapes matching size and form of existing shapes.
1. Do not use substitute materials unless otherwise indicated.
- G. Protection of Openings: Where sash or windows are indicated for removal, cover resultant openings with temporary enclosures so that openings are weathertight during repair period.
- H. Identify removed windows, frames, sash, and components with numbering system corresponding to window locations to ensure reinstallation in same location. Key windows, sash, and components to Drawings showing location of each removed unit. Permanently label units in a location that will be concealed after reinstallation.

3.4 STEEL WINDOW STRAIGHTENING

- A. Remove glass, weather stripping, and interfering hardware from sash. Remove paint buildup from between sash and frame.
- B. Using shims and gentle pressure, align and straighten sash and frame to close completely and snugly against each other, around entire perimeter of sash.
- C. Straighten and adjust hinges, latches, and other hardware so that sash and frame remain snugly against each other along entire perimeter of sash in closed and latched position.

3.5 RUST REMOVAL

- A. Rust Removal, General:
- B. Chemical Rust Removal:
 1. Remove loose rust scale with tools and abrasives to sound metal or firmly adhered rust residue. Vacuum debris from cavities.
 2. Apply rust remover with brushes or as recommended in writing by manufacturer.
 3. Allow rust remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing. Do not allow extended dwell time.
 4. Wipe off residue with mineral spirits and either steel wool or soft rags, or clean with method recommended in writing by manufacturer to remove residue.
 5. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
 6. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.
- C. Mechanical Rust Removal:
 1. Mechanical Abrasion: Where mechanical abrasion is needed for the work, use only the gentlest mechanical methods that will not damage or pit metal surfaces. Do not use abrasive methods such as sanding, wire brushing, or power tools except as indicated as part of the historic treatment program and as approved by Architect.

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2. Remove rust with tools and abrasives. Vacuum debris from cavities.
 3. Wipe off residue with mineral spirits and either steel wool or soft rags.
 4. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
 5. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

3.6 STEEL WINDOW PATCH-TYPE REPAIR

- A. General: Patch steel members that exhibit depressions, nonstructural holes, and corrosion.
 1. Remove sash from frame before performing patch-type repairs at meeting surfaces unless otherwise indicated.
 2. Verify that surfaces are sufficiently clean and free of paint residue according to steel-patching-compound manufacturer's written instructions prior to patching.
- B. Remove rust down to sound, rust-free material.
- C. Apply steel-patching compound to fill depressions, nicks, cuts, and other voids created by rusted, removed, or missing steel.
 1. Mix only as much patching compound as can be applied according to manufacturer's written instructions.
 2. Apply patching compound in layers as recommended in writing by manufacturer until the void is completely filled.
 3. Finish patch surface smooth and flush with adjacent steel, without voids in patch material, and matching contour of steel member.
 4. Clean spilled compound from adjacent materials immediately.
- D. Verify that patch repairs do not interfere with snug fit of sash and frame against each other along entire perimeter of sash in closed and latched position. If not, modify the patch repair or restraighnten window as required.

3.7 STEEL WINDOW MEMBER-REPLACEMENT REPAIR

- A. General: Replace parts of or entire steel window members at locations indicated in the Historic Steel Window Schedule and where damage is too extensive to patch.
 1. Remove sash from windows before performing member-replacement repairs unless otherwise indicated.
 2. Verify that surfaces are sufficiently clean and free of paint residue prior to repair.
 3. Straighten window as specified in "Steel Window Straightening" Article.
 4. Remove rust and broken steel down to sound, rust-free material.
 5. Cut out structurally weakened sections.
 6. Custom fabricate new steel of same size, thickness, and shape as cut-out material to replace missing steel; either replace entire steel member or splice new steel part into existing member.
 7. Weld or braze replacement material in place, and grind the repair smooth and flush with adjoining metal or filled metal as applicable.
 8. If replacement metal sections of original cross section cannot be found from salvage sources, weld flat plates into a built-up section.
- B. Repair remaining depressions, holes, or similar voids with patch-type repairs.
- C. Clean spilled materials from adjacent surfaces immediately.
- D. Glazing: Provide replacement glazing clips coordinated with glazing system indicated.
- E. Reinstall units removed for repair into original openings.
- F. Verify that member-replacement repairs do not interfere with snug fit of sash and frame against each other along entire perimeter of sash in closed and latched position. If not, modify the member-replacement repair or restraighnten window as required.

3.8 SHOP REPAIR OF WINDOWS FRAMES AND SUBFRAME REPAIR

- A. Historic treatment specialist shall recommend whether part or all of the Work may be performed at the Project site or at an off-site shop, and include this recommendation in the Steel Window Historic Treatment Program.

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- B. Remove window frames and sash from wall before performing window straightening, rust removal, patch-type repairs, and member-replacement repairs as required.
 - C. Remove rust in shop.
 - D. Perform other required historic treatment work.
 - E. Subframe: On site, examine subframe exposed by window frame removal. Protect adjacent materials, and remove rust from exposed subframe.
 - 1. Prepare and paint exposed subframe on-site as follows:
 - a. Surface Preparation: Remove paint, rust, and other contaminants according to SSPC-SP 2, "Hand Tool Cleaning," as applicable according to coating manufacturer's written instructions.
 - b. Antirust Coating: Immediately paint exposed steel with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding manufacturer's recommended rate of application (dry-film thickness per coat).
 - 2. Clean spilled materials from adjacent surfaces immediately.
 - F. If on inspection and rust removal, the thickness of a steel member is found to be reduced from rust by more than 1/16 inch (1.6 mm), notify Architect before proceeding.

3.9 GLAZING

- A. Comply with combined written instructions of manufacturers of glass, glazing system, and glazing materials unless more stringent requirements are indicated.
- B. Remove glass and glazing from openings and prepare surfaces for reglazing.
- C. Prime steel, including glazing rabbets, with finish-paint primer before installing glass.
- D. Size glass as required by Project conditions to provide necessary bite on glass and minimum edge and face clearances with reasonable tolerances.
- E. Apply primers to joint surfaces where required for adhesion of glazing system, as determined by preconstruction testing.
- F. Install setting bead, side beads, and back bead against stop in glazing rabbets before setting glass.
- G. Install glass with proper orientation so that coatings, if any, face exterior or interior as required.
- H. Install glazing clips or stops as required for glazing system.
- I. Disposal of Removed Glass: Remove from Owner's property and legally dispose of it unless otherwise indicated.

3.10 STEEL WINDOW UNIT REPLACEMENT

- A. General: Replicated steel window units may only be utilized if an historic unit is identified by Architect as missing or beyond repair. Initial condition assessment of existing historic steel units did not identify units missing or beyond repair. The following paragraph is for contingent purposes should a unit be deemed irreparable during historic treatment.
- B. Replace existing window frame and sash units with replicated steel units to match existing at locations indicated in the Historic Steel Window Schedule and where damage is too extensive to repair.
- C. Install units, hardware, accessories, and other components as indicated on Drawings and the Historic Steel Window Schedule.
- D. Install units level, plumb, square, true to line, without distortion or impeding movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.
- E. Metal Protection: Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.
- F. Disposal of Removed Units: Deliver as salvage to Owner for storage where directed.

3.11 WEATHER STRIPPING INSTALLATION

- A. General: Install weather stripping for tight seal between sash and frame as determined by preconstruction testing and demonstrated in mockup.

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- B. Application: Apply continuous bead of sealant to window frame surface against which sash frame closes. Cover applied sealant with bond-breaker strip, fully close sash, and latch in closed position. Remove extruded sealant if any.
 - C. Curing: Allow sealant to cure in closed-window joint for 28 days unless otherwise recommended in writing by sealant manufacturer.
 - D. Removing Bond-Breaker Strip: After curing time, gently open window and remove bond-breaker strip. Verify that weather stripping is continuous and neat, without spillage on other surfaces. Remove spillage if any. Wipe down joint sides with damp cloth and close sash. Verify full closure.

3.12 ADJUSTMENT

- A. Adjust existing and replacement operating sash, hardware, weather stripping, and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.

3.13 CLEANING AND PROTECTION

- A. Protect window surfaces from contact with contaminating substances resulting from construction operations. Monitor window surfaces adjacent to and below exterior concrete and masonry during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances contact window surfaces, remove contaminants immediately.
- B. Clean exposed surfaces immediately after historic treatment of steel windows. Avoid damage to coatings and finishes. Remove excess sealants, glazing and repair materials, dirt, and other substances.
- C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

3.14 HISTORIC STEEL WINDOW SCHEDULE

- A. Refer to Drawing Sheet H1.01 (Electric Pump House #3) for Historic Window Schedule.

END OF SECTION 08 03 51

SECTION 08 03 52 – HISTORIC TREATMENT OF WOOD WINDOWS

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 historic treatment of wood windows in the form of the following:
1. Repairing wood windows and trim.
 2. Replacing wood window frames and sash units.
 3. Reglazing.
 4. Repairing, refinishing, and replacing hardware.
- B. Related Requirements:
1. Retain subparagraphs below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.
 2. Section 01 2200 – Unit Prices.
 3. Section 01 3591 – Historic Treatment Procedures for general historic treatment requirements.
 4. Division 09 – Painting for repainting historic wood and new replicated wood surfaces, including paint removal, minor patching, surface preparation for refinishing, and refinishing.
 5. Section 07 9200 – “Joint Sealants”

1.3 UNIT PRICES

- A. Work of this Section is affected by unit prices specified in Section 01 2200 "Unit Prices."
1. Unit prices apply to authorized work covered by estimated quantities.
 2. Unit prices apply to authorized additions to and deletions from Work as authorized by Change Orders

1.4 DEFINITIONS

- A. Glazing: Includes glass, glazing points, glazing tapes, glazing sealants, and glazing compounds.
- B. Window: Includes window frame, sash, hardware, storm window, and exterior and interior shutters unless otherwise indicated by context.
- C. Wood Window Component Terminology: Wood window components for historic treatment work include the following classifications:
1. Revise list below to suit Project.
 2. Frame Components: Head, jambs, and sill.
 3. Sash Components: Stiles and rails, parting bead, stop, and muntins.
 4. Exterior Trim: Exterior casing, brick mold, and cornice or drip cap.
 5. Interior Trim: Casing, stool, and apron.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project Site.
1. Review minutes of Preliminary Historic Treatment Conference that pertain to historic treatment of wood windows.
 2. Review methods and procedures related to historic treatment of wood windows including, but not limited to, the following:
 - a. Historic treatment specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, material application, sequencing, tolerances, and required clearances.

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- c. Site access requirements and hours of operations.
 - d. Erection sequencing, anchoring, and safety requirements of scaffolding, lifts and hoistways, if required.
 - e. Coordination of scaffolding, lifts and hoistways access and use for all applicable rehabilitation work.
 - f. VFire-protection plan.
 - g. Wood window historic treatment program
 - h. Quality-control program.
 - i. Coordination with building occupants.
 - j. Coordination with other trades working in close proximity to historic wood windows who may impact the work, or may be impacted by the work, including shared use of scaffolding.
 - k. Review safety precautions and requirements due to unique site conditions:
 - 1) Work within and under City Public Service (CPS) utility easements.
 - 2) Potential road lane and sidewalk closures to permit erection of scaffolding.

1.6 SEQUENCING AND SCHEDULING

- A. Perform historic treatment of wood windows in the following sequence, which includes work specified in this and other Sections:
 - 1. Label each window frame with permanent opening-identification number in inconspicuous location.
 - 2. Tag existing window sash, storm windows, and shutters with opening-identification numbers and remove for on-site or off-site repair. Indicate on tags the locations on window of each component, such as "top sash," "bottom sash," "left shutter," and "right shutter."
 - 3. Remove window, dismantle hardware, and tag hardware with opening-identification numbers.
 - 4. Install temporary protection and security at window openings.
 - 5. In the shop, label each sash, storm window, shutter, and louvered blind unit with permanent opening-identification number in inconspicuous location and remove site-applied tags.
 - 6. Sort units by condition, separating those that need extensive repair.
 - 7. Clean surfaces.
 - 8. General Wood-Repair Sequence:
 - a. Remove paint to bare wood.
 - b. Rack frames slightly to inject adhesive into mortise and tenon joints; square frames to proper fit before adhesive sets.
 - c. If thicker than original glass is required, rout existing muntins to required rebate size.
 - d. Repair wood by consolidation, member replacement, partial member replacement, and patching.
 - e. Sand, prime, fill, sand again, and prime surfaces again for refinishing.
 - 9. Repair, refinish, and replace hardware if required. Reinstall operating hardware.
 - 10. Install glazing.
 - 11. Remove temporary protection and security at window openings.
 - 12. Reinstall units.
 - 13. Apply finish coats.
 - 14. Install remaining hardware and weather stripping.

1.7 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include recommendations for product application and use. Include test data substantiating that products comply with requirements.
- B. Shop Drawings:
 - 1. Include plans, elevations, and sections showing locations and extent of repair and replacement work, with enlarged details of replacement parts indicating materials, profiles, joinery,

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- reinforcing, method of splicing into or attaching to existing wood window, accessory items, and finishes.
2. Include field-verified dimensions and the following:
 - a. Full-size shapes and profiles with complete dimensions for replacement components and their jointing, showing relation of existing to new components.
 - b. Templates and directions for installing hardware and anchorages.
 - c. Identification of each new unit and its corresponding window locations in the building on annotated plans and elevations.
 - d. Provisions for sealant joints, flashing, and as required for location.
 3. Samples for Initial Selection: For each type of exposed wood and finish.
 4. Identify wood species, cut, and other features.
 5. Include Samples of hardware and accessories involving color selection.
- C. Samples for Verification: For the following products in manufacturer's standard sizes unless otherwise indicated, finished as required for use in the Work:
1. Replacement Units: 12-inch- (300-mm-) long, full-size frame and sash sections with applied finish.
 2. Replacement Members: 12 inches (300 mm) long for each replacement member, including parts of frame, sash, exterior trim, and interior trim.
 - a. Additional Samples of replacement members that show fabrication techniques, materials, and finishes as requested by Architect.
 3. Repaired Wood Window Members: Prepare Samples using existing wood window members removed from site, repaired, and prepared for refinishing.
 4. Refinished Wood Window Members: Prepare Samples using existing wood window members removed from site, repaired, and refinished.
 5. Hardware: Full-size units with each factory-applied or restored finish.
 6. Weather Stripping: 12-inch- (300-mm-) long sections.
 7. Glass: Full-size units of each type and appearance.

1.8 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For historic treatment specialist, including workers and wood-repair-material manufacturer.
- B. Wood Window Historic Treatment Program: Submit before work begins.
- C. Preconstruction Test Reports: For historic treatment of wood windows.

1.9 QUALITY ASSURANCE

- A. Basis for Standard of Care: U.S. Department of the Interior – National Park Service – Standards and Guidelines for Historic Rehabilitation.
- B. Historic Treatment Specialist Qualifications: See Section 01 3591 - Historic Treatment Procedures for general qualifications of historic treatment specialist. A qualified historic wood window specialist, experienced in repairing, refinishing, and replacing wood windows in whole and in part. Experience only in fabricating and installing new wood windows is insufficient experience for wood-window historic treatment work.
 1. A list of similar jobs, completed within the last three years, shall be provided. Identify when, where, and for whom the work was performed.
- C. Wood-Repair-Material Manufacturer Qualifications: A firm regularly engaged in producing wood consolidant and wood-patching compound that have been used for similar historic wood-treatment applications with successful results, and with factory-authorized service representatives who are available for consultation and Project-site inspection and on-site assistance.
- D. Wood Window Historic Treatment Program: Prepare a written, detailed description of materials, methods, equipment, and sequence of operations to be used for historic treatment work, including protection of surrounding materials and Project site.

1. If materials and methods other than those indicated are proposed for any phase of historic treatment work, add a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project.
2. Mockups: Prepare mockups of historic treatment repair processes to demonstrate aesthetic effects and to set quality standards for materials and execution and for fabrication and installation. Prepare mockups so they are as inconspicuous as practicable.
3. Locate mockups on existing windows where directed by Architect.
4. Wood Window Repair: Prepare one entire window unit to serve as mockup to demonstrate samples of each type of repair of wood window members including frame, sash, glazing, and hardware.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified historic treatment specialist to perform preconstruction testing on historic wood windows.
1. Provide test specimens representative of proposed materials and existing construction.
 2. Test historic treatment products and methods for effectiveness and compliance with specified requirements.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Pack, deliver, and store products in suitable packs, heavy-duty cartons, or wooden crates; surround with sufficient packing material to ensure that products are not deformed, broken, or otherwise damaged.
- B. Store products inside a well-ventilated area and protect from weather, moisture, soiling, abrasion, extreme temperatures, and humidity, and where environmental conditions comply with manufacturer's requirements.

1.12 FIELD CONDITIONS

- A. Weather Limitations: Proceed with historic treatment of wood windows only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.

PART 2 - PRODUCTS

2.1 HISTORIC TREATMENT OF WOOD WINDOWS, GENERAL

- A. Quality Standard: Comply with applicable requirements in Section 12, "Historic Restoration Work," and related requirements in AWI/AWMAC/WI's "Architectural Woodwork Standards" for construction, finishes, grades of wood windows, and other requirements unless otherwise indicated.
1. Exception: Industry practices cited in Section 12, Article 1.5, Industry Practices, of the Architectural Woodwork Standards do not apply to the work of this Section.

2.2 WOOD-BASED COMPONENTS

- A. Wood fabricated from old growth timber is not permitted.
1. Exception: Old growth timber is permitted if wood is obtained from documented reclaimed source(s) and otherwise complies with applicable requirements.

2.3 REPLICATED WOOD WINDOW UNITS

- A. Replicated Wood Window Frames and Sash: Custom-fabricated replacement wood units and trim, with operating and latching hardware.
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. Basis of Design Manufacturers:
 - 1) Hallmark Cabinetry and Millwork, 326 Melrose Place, San Antonio, Texas 78212. Contact: John Hall at 210-828-8779.
 - 2) Architectural Interiors, 1350 E. Southcross Blvd., San Antonio, Texas 78223. Contact: Victor Salas at 210-319-4192.
 - 3) GW Cernoch Works 602 Utex Dr, Weimar, Texas 78962, 979-725-8975,
 - 4) Red River Restorations 116 Hoxie Street, Coupland, Texas 78615, 512-998-3432
 - 5) Barron Restorations 10509 Old Manchaca Rd, Austin, Texas 78748, 214-810-0232
 2. Adams Architectural Millwork Co.; Subsidiary of Dubuque Sash & Door Mfg.
 3. Allegheny Restoration & Builders Inc.
 4. Architectural Components, Inc.
 5. Bear Wood Windows, Inc.
 6. Cleary and Son, Inc.
 7. Custom Wood Reproductions Inc.
 8. Grabill Windows & Doors.
 9. H. Hirschmann LTD.
 10. Kingsland Architectural Millwork.
 11. Olek Lejbzon & Co.
 12. Parrett Manufacturing, Inc.
 13. Replica Windows.
 14. Smith Restoration Sash.
 15. Weston Millwork Company.
 16. Wewoka Window Works.
 17. Woodstone Company (The).
 18. Wood Window Workshop.
 19. Joint Construction: Joints matching existing.
 20. Wood Species: Match wood species of exterior window trim and sash parts.
 21. Wood Cut: Match cut of existing exterior wood window trim and sash parts.
 22. Wood Window Members and Trim: Match profiles and detail of existing window members and trim.
 23. Glazing Stops: Provide replacement glazing stops coordinated with glazing system indicated.
 24. Exposed Hardware: Reuse or match where missing existing exposed window hardware.
 25. Weather Stripping: Full-perimeter and meeting rail weather stripping for each operable sash.
 26. Date Identification: Emboss on a concealed surface of each replaced window frame and sash, in easily read characters, "WINDOW MADE 2023 or "SASH MADE 2023 Manufacturer's name may also be embossed.

2.4 WOOD-REPLACEMENT MATERIALS

- A. Wood, General: Clear fine-grained lumber; kiln dried to a moisture content of 6 to 12 percent at time of fabrication; free of visible finger joints, blue stain, knots, pitch pockets, and surface checks larger than 1/32 inch (0.8 mm) deep by 2 inches (51 mm) wide.
1. Species: Match species of each existing type of wood component or assembly unless otherwise indicated.
- B. Frame Heads and Jambs and Exterior Trim: Match existing species.
- C. Exterior Trim: Match existing species.

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- D. Sills: Match existing species.
 - E. Sash Components: Match existing species.
 - F. Interior Trim: Match existing species.

2.5 WOOD-REPAIR MATERIALS

- A. Source Limitations: Obtain wood consolidant and wood-patching compound from single source from single manufacturer.
- B. Wood Consolidant: Ready-to-use product designed to penetrate, consolidate, and strengthen soft fibers of wood materials that have deteriorated due to weathering and decay and designed specifically to enhance the bond of wood-patching compound to existing wood.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Abatron, Inc.; LiquidWood.
 - b. ConServ Epoxy LLC; Flexible Epoxy Consolidant 100.
 - c. Gougeon Brothers, Inc.; West System.
 - d. Protective Coating Company; PC-Petrifier or PC-Rot Terminator.
 - e. System Three Resins, Inc.; RotFix.
- C. Wood-Patching Compound: Two-part epoxy-resin wood-patching compound; knife-grade formulation as recommended in writing by manufacturer for type of wood repair indicated, tooling time required for the detail of work, and site conditions. Compound shall be designed for filling voids in damaged wood materials that have deteriorated due to weathering and decay. Compound shall be capable of filling deep holes and spreading to feather edge.
 - 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. Abatron, Inc.; LiquidWood with WoodEpoxy.
 - b. Advanced Repair Technology, Inc.; Primatrate with Flex-Tec HV.
 - c. ConServ Epoxy LLC; Flexible Epoxy Consolidant 100 with Flexible Epoxy Patch 200.
 - d. Gougeon Brothers, Inc.; West System thickened with filler.
 - e. Polymeric Systems, Inc.; QuickWood.
 - f. Protective Coating Company; PC-Woody.
 - g. System Three Resins, Inc.; Sculpwood.

2.6 GLAZING MATERIALS

- A. Glass: Uncoated clear float-glass units. Tempered as required by code.
- B. Glazing Systems:
 - 1. Traditional Glazing Products: Glazing points and oil-based glazing putty or latex glazing compound. Tint to required color according to manufacturer's written instructions.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) DAP Products Inc.; DAP 33 Glazing or DAP Latex Window Glazing.
 - 2) Sarco Putty Company, Inc.; SarcoSeal Dual Glaze Elastic Glazing Compound or SarcoSeal Multi-Glaze Elastic Glazing Compound Type M.
 - 3) United Gilsonite Laboratories; Glazol Glazing Compound.
 - 2. Modern Glazing Products: Glazing points and single-component polyurethane glazing compound; ASTM C 920, Type S, Grade NS, Class 25, Use G; struck uniformly to match taper of existing glazing putty (removed); colored as required to match painted sash.
 - 3. Primers and Cleaners for Glazing: As recommended in writing by glazing material manufacturer.

2.7 **HARDWARE**

- A. Window Hardware: Retain as much original material as possible to perform required repairs for proper operation. Provide complete sets of window hardware consisting of sash balances, hinges, pulls, latches, and accessories indicated for each window or required for proper operation. Sets shall include replacement hardware to complement repaired and refinished, existing hardware. Window hardware shall smoothly operate, tightly close, and securely lock wood windows and be sized to accommodate sash or ventilator weight and dimensions.
- B. Replacement Hardware: Replace existing damaged or missing hardware with new hardware manufactured by one of the following:
 - 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. Architectural Resource Center (The).
 - b. Ball and Ball.
 - c. Blaine Window Hardware Inc.
 - d. Bronze Craft Corporation (The).
 - e. Phelps Company.
 - f. Smith Restoration Sash.
- C. Material and Design:
 - 1. Material: Solid bronze of alloy indicated unless otherwise indicated.
 - 2. Design: Match type and appearance of existing hardware.
 - 3. Weight and Pulley Sash-Balance: Concealed weight and pulley balance system including steel or cast iron weights, cast-bronze pulleys, size and capacity to hold sash stationary at any open position.
 - 4. Replacement Window Hardware: Match existing window hardware of the following types:
 - a. Casement window hinge.
 - b. Window lock.
 - c. Window latch.
 - d. Handle.
 - 5. Date Identification: Emboss on a concealed surface of the metal body of each new hardware item, in easily read characters, "MADE 2018". Manufacturer's name may also be embossed. For cast iron or other brittle metals, add the identification to the mold pattern before casting. For malleable metals, stamp identification with an imprinting tool.
- D. Hardware Finishes: Comply with BHMA A156.18 for base material and finish requirements indicated by the following:
 - 1. BHMA 613: Dark-oxidized satin bronze, oil-rubbed; bronze base metal.

2.8 **WEATHER STRIPPING**

- A. Sliding-Type Weather Stripping: Woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric.
 - 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. National Guard Products, Inc.
 - b. Pemko Manufacturing Co., Inc.; an ASSA ABLOY company.
 - c. Reese Enterprises, Inc.
 - d. Zero International, Inc.
 - 2. Weather Seals: Provide weather stripping with integral barrier fin or fins of semirigid, polypropylene sheet or polypropylene-coated material.

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- B. Metal Weather Stripping: Bronze weather stripping; designed either as one piece to seal by sliding into a groove in the sash or as two pieces that interlock; and completely concealed when window is closed.
 - 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. Accurate Metal Weatherstrip Co. Inc.
 - b. Zero International, Inc.

2.9 MISCELLANEOUS MATERIALS

- A. Borate Preservative Treatment: Inorganic, borate-based solution, with disodium octaborate tetrahydrate as the primary ingredient; manufactured for preserving weathered and decayed wood from further damage by decay fungi and wood-boring insects; complying with AWPA P5; containing no boric acid.
 - 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:
 - 2. Abatron, Inc.
 - 3. Nisus Corporation.
 - 4. System Three Resins, Inc.
- B. Cleaning Materials:
 - 1. Detergent Solution: Solution prepared by mixing 2 cups (0.5 L) of tetrasodium pyrophosphate (TSPP), 1/2 cup (125 mL) of laundry detergent that contains no ammonia, 5 quarts (5 L) of 5 percent sodium hypochlorite bleach, and 15 quarts (15 L) of warm water for each 5 gal. (20 L) of solution required.
 - 2. Mildewcide: Commercial, proprietary mildewcide or a solution prepared by mixing 1/3 cup (80 mL) of household detergent that contains no ammonia, 1 quart (1 L) of 5 percent sodium hypochlorite bleach, and 3 quarts (3 L) of warm water.
- C. Adhesives: Wood adhesives for exterior exposure, with minimum 15- to 45-minute cure at 70 deg F (21 deg C), in gunnable and liquid formulations as recommended in writing by adhesive manufacturer for each type of repair.
- D. Fasteners: Use fastener metals that are noncorrosive and compatible with each material joined.
 - 1. Match existing fasteners in material and type of fastener unless otherwise indicated.
 - 2. Use concealed fasteners for interconnecting wood components.
 - 3. Use concealed fasteners for attaching items to other work unless exposed fasteners are unavoidable or the existing fastening method.
 - 4. For fastening metals, use fasteners of same basic metal as fastened metal unless otherwise indicated.
 - 5. For exposed fasteners, use Phillips-type machine screws of head profile flush with metal surface unless otherwise indicated.
 - 6. Finish exposed fasteners to match finish of metal fastened unless otherwise indicated.
- E. Anchors, Clips, and Accessories: Fabricate anchors, clips, and window accessories of aluminum, nonmagnetic stainless steel, or hot-dip zinc-coated steel complying with requirements in ASTM B 633 for SC 3 (Severe) service condition.

2.10 WOOD WINDOW FINISHES

- A. Factory-Primed Replacement Units: Manufacturer's standard factory-prime coat on exposed exterior and interior wood surfaces; compatible with indicated finish coating.
- B. Factory-Finished Units: Alkyd finish system consisting of primer and two finish coats on exposed exterior and interior wood surfaces.
 - 1. Finish Coats: Match intermediate coat and topcoat products used for adjacent, repaired wood windows, as specified in Section 09 0391 "Historic Treatment of Plain Painting."

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2. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 HISTORIC TREATMENT SPECIALIST

- A. Historic Treatment Specialist Firms: Subject to compliance with requirements, provide historic treatment of wood windows by one of the following firms that may provide historic treatment of wood windows include, but are not limited to, the following:
 1. Hallmark Cabinetry and Millwork, 326 Melrose Place San Antonio, Texas 78212 Contact: John Hall 210-828-8779.
 2. Architectural Interiors, 1350 E. Southcross Blvd. San Antonio, Texas 78223 Victor Salas 210-319-4192.

3.2 PREPARATION

- A. Protect adjacent materials from damage by historic treatment of wood windows.
- B. Clean wood windows of mildew, algae, moss, plant material, loose paint, grease, dirt, and other debris by scrubbing with bristle brush or sponge and detergent solution. Scrub mildewed areas with mildewcide. After cleaning, rinse thoroughly with fresh water. Allow to dry before repairing or painting.
- C. Condition replacement wood members and replacement units to prevailing conditions at installation areas before installing.

3.3 HISTORIC TREATMENT OF WOOD WINDOWS, GENERAL

- A. Historic Treatment Appearance Standard: Completed work is to have a uniform appearance as viewed by Architect from the window interior at 5 feet (1.5 m) away and from the window exterior at 10 feet (3 m) away.
- B. General: In treating historic items, disturb them as minimally as possible and as follows:
 1. Stabilize and repair wood windows to reestablish structural integrity and weather resistance while maintaining the existing form of each item.
 2. Remove coatings and apply borate preservative treatment before repair. Remove coatings according to Section 090391 "Historic Treatment of Plain Painting" unless otherwise indicated.
 3. Repair items in place where possible.
 4. Install temporary protective measures to protect wood window work that is indicated to be completed later.
 5. Refinish historic wood windows according to Section 090391 "Historic Treatment of Plain Painting" unless otherwise indicated.
- C. Mechanical Abrasion: Where mechanical abrasion is needed for the work, use only the gentlest mechanical methods, such as scraping and natural-fiber bristle brushing, that will not abrade wood substrate, reducing clarity of detail. Do not use abrasive methods such as sanding, wire brushing, or power tools except as indicated as part of the historic treatment program and as approved by Architect.
- D. Repair and Refinish Existing Hardware: Dismantle window hardware; strip paint, repair, and refinish it to match finish samples; and lubricate moving parts just enough to function smoothly.
- E. Repair Wood Windows: Match existing materials and features, retaining as much original material as possible to perform repairs.
 1. Unless otherwise indicated, repair wood windows by consolidating, patching, splicing, or otherwise reinforcing wood with new wood matching existing wood or with salvaged, sound, original wood.
 2. Where indicated, repair wood windows by limited replacement matching existing material.
 3. Sash Balance: Repair sash balances to function according to type as specified in "Hardware" Article" above. Provide missing sash balances.

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- F. Replace Wood Units: Where indicated, duplicate and replace units with units made from salvaged, sound, original wood or with new wood matching existing wood. Use surviving prototypes to create patterns for duplicate replacements.
 - 1. Do not use substitute materials unless otherwise indicated.
 - 2. Compatible substitute materials may be used.
 - G. Protection of Openings: Where sash or windows are indicated for removal, cover resultant openings with temporary enclosures so that openings are weathertight during repair period.
 - H. Identify removed windows, frames, sash, and members with numbering system corresponding to window locations to ensure reinstallation in same location. Key windows, sash, and members to Drawings showing location of each removed unit. Permanently label units in a location that will be concealed after reinstallation.

3.4 WOOD WINDOW PATCH-TYPE REPAIR

- A. General: Patch wood members that exhibit depressions, holes, or similar voids, and that have limited amounts of rotted or decayed wood.
 - 1. Remove sashes from windows before performing patch-type repairs at meeting or sliding surfaces unless otherwise indicated. Reglaze units before reinstallation.
 - 2. Verify that surfaces are sufficiently clean and free of paint residue before patching.
 - 3. Treat wood members with wood consolidant before applying patching compound. Coat wood surfaces by brushing, applying multiple coats until wood is saturated and unable to absorb more. Allow treatment to harden before filling void with patching compound.
 - 4. Remove rotted or decayed wood down to sound wood.
- B. Apply borate preservative treatment to accessible surfaces either before applying wood consolidant or after removing rotted or decayed wood. Apply treatment liberally by brush to joints, edges, and ends; top, sides, and bottom. Allow treatment to dry.
- C. Apply wood-patching compound to fill depressions, nicks, cracks, and other voids created by removed or missing wood.
 - 1. Prime patch area with application of wood consolidant or manufacturer's recommended primer.
 - 2. Mix only as much patching compound as can be applied according to manufacturer's written instructions.
 - 3. Apply patching compound in layers as recommended in writing by manufacturer until the void is completely filled.
- 4. Sand patch surface smooth and flush with adjacent wood, without voids in patch material, and matching contour of wood member.
- 5. Clean spilled compound from adjacent materials immediately.

3.5 WOOD WINDOW MEMBER-REPLACEMENT REPAIR

- A. General: Replace parts of or entire wood window members at locations where damage is too extensive to patch.
 - 1. Remove sashes from windows before performing member-replacement repairs unless otherwise indicated.
 - 2. Verify that surfaces are sufficiently clean and free of paint residue before repair.
 - 3. Remove broken, rotted, and decayed wood down to sound wood.
 - 4. Custom fabricate new wood to replace missing wood; either replace entire wood member or splice new wood part into existing member.
 - 5. Secure new wood using finger joints, multiple dowels, or splines with adhesive and nailing to ensure maximum structural integrity at each splice. Use only concealed fasteners. Fill nail holes and patch surface to match surrounding sound wood.
- B. Apply borate preservative treatment to accessible surfaces after replacements are made. Apply treatment liberally by brush to joints, edges, and ends; top, sides, and bottom.
- C. Repair remaining depressions, holes, or similar voids with patch-type repairs.

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- D. Clean spilled materials from adjacent surfaces immediately.
 - E. Glazing: Reglaze units before reinstallation.
 - 1. Mill new and rout existing glazed members to accommodate new glass thickness.
 - 2. Provide replacement glazing stops coordinated with glazing system indicated.
 - 3. Provide glazing stops to match contour of sash frames.
 - F. Reinstall units removed for repair into original openings.
 - G. Weather Stripping: Replace nonfunctioning and install missing weather stripping to ensure full-perimeter and meeting rail weather stripping for each operable sash.

3.6 GLAZING

- A. Comply with combined written instructions of manufacturers of glass, glazing systems, and glazing materials, unless more stringent requirements are indicated.
- B. Remove cracked and damaged glass and glazing materials from openings and prepare surfaces for reglazing.
- C. Remove existing glass and glazing where indicated on the drawings or where damage is too extensive, and prepare surfaces for reglazing.
- D. Remove glass and glazing from openings and prepare surfaces for reglazing.
- E. Size glass as required by Project conditions to provide necessary bite on glass, minimum edge and face clearances, with reasonable tolerances.
- F. Apply primers to joint surfaces where required for adhesion of glazing system, as determined by preconstruction testing.
- G. Install setting bead, side beads, and back bead against stop in glazing rabbets before setting glass.
- H. Install glass with proper orientation so that coatings, if any, face exterior or interior as required.
- I. Install glazing points.
- J. Disposal of Removed Glass: Remove from Owner's property and legally dispose of it unless otherwise indicated.

3.7 WOOD WINDOW UNIT REPLACEMENT

- A. General: Replace existing wood window frame and sash units with new custom-fabricated units to match existing at locations indicated on Drawings or where damage is too extensive to repair.
- B. Apply borate preservative treatment to accessible surfaces before finishing. Apply treatment liberally by brush to joints, edges, and ends; top, sides, and bottom.
- C. Mill glazed members to accommodate glass thickness. Glaze units before installation.
- D. Install units, hardware, weather stripping, accessories, and other components as indicated on Drawings and in locations existing damage is too extensive to repair.
- E. Install units level, plumb, square, true to line, without distortion or impeding movement; anchored securely in place to structural support; and in proper relation to wall flashing, trim, and other adjacent construction.
- F. Set sill members in bed of sealant for weathertight construction unless otherwise indicated.
- G. Install window units with new anchors into existing openings.
- H. Weather Stripping: Install full-perimeter and meeting rail weather stripping for each operable sash.
- I. Metal Protection: Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.
- J. Disposal of Removed Units: Remove from Owner's property and legally dispose of them.

3.8 WEATHER STRIPPING INSTALLATION

- A. Install weather stripping for tight seal of joints as determined by preconstruction testing and demonstrated in mockup.

3.9 FIELD QUALITY CONTROL

- A. Manufacturers Field Service: Engage wood-repair-material manufacturers' factory-authorized service representatives for consultation and Project-site inspection and to provide on-site assistance when requested by Architect.

3.10 ADJUSTING

- A. Adjust existing and replacement operating sash, screens, hardware, weather stripping, and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.

3.11 CLEANING AND PROTECTION

- A. Protect window surfaces from contact with contaminating substances resulting from construction operations. Monitor window surfaces adjacent to and below exterior concrete and masonry during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances contact window surfaces, remove contaminants immediately.
- B. Clean exposed surfaces immediately after historic treatment of wood windows. Avoid damage to coatings and finishes. Remove excess sealants, glazing and patching materials, dirt, and other substances.
- C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction.

3.12 HISTORIC WOOD WINDOW SCHEDULE

- A. Refer to Drawing Sheets: H0.01 (Pump House), H5.01 (Pavilion A) and H5.01 (Pavilion B) for Historic Window Schedule.

END OF SECTION 08 03 52

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hollow steel doors and frames.

B. Related Sections:

1. Division 01: Administrative, procedural, and temporary work requirements.
2. Section 087100 - Door Hardware.

1.2 REFERENCES

A. American National Standards Institute (ANSI)/Steel Door Institute (SDI):

1. A250.3 - Test Procedure and Acceptance Criteria for Factory Applied Finished Painted Steel for Steel Doors and Frames.
2. A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frame Anchors and Hardware Reinforcings.
3. A250.8 - Recommended Specifications for Standard Steel Doors and Frames.
4. A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
5. A250.11 - Recommended Erection Instructions for Steel Frames.

B. ASTM International (ASTM):

1. A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
2. A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
3. A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
4. C518 - Standard Test Method for Steady State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
5. E413 - Classification for Rating Sound Insulation.

C. National Fire Protection Association (NFPA) 80 - Standard for Fire Doors and Fire Windows.

D. Steel Door Institute (SDI) 117 - Manufacturing Tolerances for Standard Steel Doors and Frames.

E. Underwriters Laboratories (UL):

1. 10B - Standard for Fire Tests of Door Assemblies.
2. 10C - Standard for Positive Pressure Fire Tests of Door Assemblies.

1.3 SUBMITTALS

A. Submittals for Review:

1. Shop Drawings: Show locations, elevations, dimensions, model designations, [fire] [thermal] [acoustical] ratings, preparation for hardware, and anchoring details.

2. Product Data: Show elevations, dimensions, gages of metal, hardware reinforcing gages and locations, and anchor types.
- B. Quality Control Submittals:
1. Certificates of Compliance: Certification that products furnished comply with ANSI/SDI A250.3, ANSI/SDI 250.4, and ANSI/SDI A250.10.
- C. Sustainable Design Submittals:
1. Recycled Content.
 2. Regional Materials.

1.4 QUALITY ASSURANCE

- A. Doors: ANSI/SDI A250.8.
1. Grade: [I - Standard Duty.] [II - Heavy Duty.] [III - Extra Heavy Duty.]
 2. Model: [1 - Full Flush.] [1A - Full Flush.] [2 - Seamless.] [2A - Seamless.] [3 - Stile and Rail - Flush Panel.]
 3. Exterior doors: Maximum thermal transmittance (U-value) of [0.50,] [___,] tested to ASTM C518.
- B. Frames: ANSI/SDI A250.8, Grade II - Heavy Duty.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Ship door frames with removable angle spreader; do not remove until frame is installed.
- B. Store doors upright in protected, dry area, off ground or floor, with at least 1/4 inch space between individual units.
- C. Do not cover with non-vented coverings that create excessive humidity.
- D. Remove wet coverings immediately.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
1. Ceco Door. (www.cecodoor.com)
 2. Curries. (www.curries.com)
 3. Pioneer Industries, Inc. (www.pioneerindustries.com)
 4. Steelcraft. (www.steelcraft.com)
- B. Substitutions: [Under provisions of Division 01.] [Not permitted.]

2.2 MATERIALS

- A. Galvanized Steel Sheet:
1. ASTM A653/A653M, hot dipped, Structural Quality, Class G90 galvanized.

**** OR ****

- B. Galvannealed Steel Sheet:
1. ASTM A924, Class A60 galvannealed.

- C. Door Core:
 - 1. Exterior doors: [Foamed-in-place polyurethane insulation] [Rigid polystyrene insulation]
- D. Batt Insulation: Mineral wool type.

2.3 ACCESSORIES

- A. Glass, Glazing Sealers, and Accessories: Specified in Section 088000.
- B. Primer: Zinc rich type.

2.4 FABRICATION

- A. Fabricate doors and frames in accordance with ANSI/SDI A250.8.
- B. Fabricate exterior doors and frames from [galvanized] [galvannealed] steel sheet.
- C. Fabricate exterior frames with 3/8 inch vinyl thermal break separating interior and exterior surfaces.
- D. Doors:
 - 1. Fabricate from minimum 16 gage sheets.
 - 2. Close top and bottom edges of doors with steel channel, minimum 16 gage, extending full width of door, and spot welded to both faces, with top channel flush and bottom channel recessed.
 - 3. Fill voids between vertical steel stiffeners with batt insulation.
 - 4. Fabricate vertical door edges as vertical seam edge filled, dressed smooth, intermittently welded seams, edge filled, dressed smooth, or continuously welded seam, dressed smooth.
- E. Frames:
 - 1. Fabricate from minimum 14 gage sheets
 - 2. Close corner joints tight with trim faces mitered and face welded, full profile welded, or continuously welded and ground smooth.
 - 3. Anchors:
 - a. Provide one anchor at each jamb for each [30] inches of door height.
 - b. Design anchors to provide positive fastenings to adjacent construction.
 - c. Provide one floor anchor welded to each jamb.
 - 4. Terminate stops [6] inches above finished floor. Cut bottom edge of stop at 45 degree angle and close.
 - 5. Where frames will be filled with concrete or grout, install silencers in frames before erection.
 - 6. Mullions for paired doors: [Fixed] [Removable] type, of same profiles as jambs.
- F. Accurately form to required sizes and profiles.
- G. Grind and dress exposed welds to form smooth, flush surfaces.
- H. Do not use metallic filler to conceal manufacturing defects.
- I. Fabricate with internal reinforcement for hardware specified in Section 08 71 00; weld in place.
- J. Design Clearances:
 - 1. Between door and frame: Maximum 1/8 inch.
 - 2. Between meeting edges of pairs of doors:
 - a. Non-fire rated doors: 3/16 inch plus or minus 1/16 inch.

- b. Fire-rated doors: 1/8 inch plus or minus 1/16 inch.
- 3. Undercut:
 - a. Non-fire rated doors: Maximum 3/4 inch.
 - b. Fire-rated doors: Comply with NFPA 80.
- 4. Between face of door and stop: 1/16 to 3/32 inch.

K. Manufacturing Tolerances: In accordance with SDI-117.

2.5 FINISHES

- A. Dress tool marks and surface imperfections to smooth surfaces.
- B. Clean and chemically treat steel surfaces.
- C. Touch up damaged metallic coatings.
- D. Apply manufacturer's standard rust inhibiting primer paint, air-dried or baked on, meeting requirements of ANSI/SDI A250.10.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install doors and frames in accordance with ANSI/SDI A250.11.
- B. Set plumb and level.
- C. Secure to adjacent construction using fastener type best suited to application.
- D. Install hardware in accordance with Section 08 71 00.

3.2 ADJUSTING

- A. Touch up minor scratches and abrasions in primer paint to match factory finish.

END OF SECTION

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hollow steel doors and frames.

B. Related Sections:

1. Division 01: Administrative, procedural, and temporary work requirements.
2. Section 087100 - Door Hardware.

1.2 SUBMITTALS

A. Submittals for Review:

1. Shop Drawings: Show locations, elevations, dimensions, model designations, fire and thermal ratings, preparation for hardware, and anchoring details.
2. Product Data: Show elevations, dimensions, gages of metal, hardware reinforcing gages and locations, and anchor types.

B. Quality Control Submittals:

1. Certificates of Compliance: Certification that products furnished comply with ANSI/SDI A250.3, ANSI/SDI 250.4, and ANSI/SDI A250.10.

1.3 QUALITY ASSURANCE

A. Doors: ANSI/SDI A250.8.

1. Grade: II - Heavy Duty.
2. Model: 1 - Full Flush.
3. Finish: Stainless Steel to match MTL-1.

B. Frames: ANSI/SDI A250.8, Grade II - Heavy Duty.

1.4 DELIVERY, STORAGE AND HANDLING

A. Ship door frames with removable angle spreader; do not remove until frame is installed.

B. Store doors upright in protected, dry area, off ground or floor, with at least 1/4 inch space between individual units.

C. Do not cover with non vented coverings that create excessive humidity.

D. Remove wet coverings immediately.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Assa Abloy Group company (www.assaabloy.com)
 - 2. Steelcraft. (www.steelcraft.com)
- B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. Hollow Metal Doors and Frames:
 - 1. Thickness: 1-3/4 inch.
 - 2. Door Core: Foamed-in-place polyurethane insulation manufactured using low-emitting, urea formaldehyde-free binders.
- B. Steel Sheet: ASTM A1008/1008M, cold rolled.
- C. Galvanized Steel Sheet: ASTM A653/A653M, hot dipped, Structural Quality, Class G40 galvanized.

2.3 ACCESSORIES

- A. Glass, Glazing Sealants, and Accessories: Specified in Section 088000.
- B. Primer: Zinc rich type.
- C. Door Hardware: Specified in Section 087100.
 - 1. Unit entry door hardware: All unit entry doors shall have a lever key-lock latch, doorknocker, security accessories (eyelet and deadbolt), and kick plate.
 - 2. All doors shall be equipped with lever-handle hardware.
 - 3. All bedrooms and bathrooms shall be equipped with privacy locks.

2.4 FABRICATION

- A. Fabricate doors and frames in accordance with ANSI/SDI A250.8.
- B. Fabricate exterior doors and frames from galvanized steel sheet.
- C. Fabricate exterior frames with 3/8 inch vinyl thermal break separating interior and exterior surfaces.
- D. Doors:
 - 1. Fabricate from minimum 18 gage sheets.

2. Close top and bottom edges of doors with steel channel, minimum 16 gage, extending full width of door, and spot welded to both faces, with top channel flush and bottom channel recessed.
 3. Louvers (Provide at Lower Portion of Doors to Pavilion B, refer to Door Schedule):
 - a. Manufacturer's standard, inverted "Y" blade type.
 - b. Frames: Minimum 20 gage steel.
 - c. Blades: Minimum 24 gage steel.
 - d. Weld blades to frame with one molding integral with louver.
 - e. Install loose molding on secure side of door.
 - E. Frames:
 1. Fabricate from minimum 16 gage sheets.
 2. Close corner joints tight with trim faces mitered and face welded, full profile welded, or continuously welded and ground smooth.
 3. Anchors:
 - a. Provide one anchor at each jamb for each 30 inches of door height.
 - b. Design anchors to provide positive fastenings to adjacent construction.
 - c. Provide one floor anchor welded to each jamb.
 - F. Accurately form to required sizes and profiles.
 - G. Grind and dress exposed welds to form smooth, flush surfaces.
 - H. Do not use metallic filler to conceal manufacturing defects.
 - I. Fabricate with internal reinforcement for hardware specified in Section 087100; weld in place.
 - J. Design Clearances:
 1. Between door and frame: Maximum 1/8 inch.
 2. Between meeting edges of pairs of doors:
 - a. Non-fire rated doors: 3/16 inch plus or minus 1/16 inch.
 - b. Fire-rated doors: 1/8 inch plus or minus 1/16 inch.
 3. Undercut:
 - a. Non-fire rated doors: Maximum 3/4 inch.
 - b. Fire-rated doors: Comply with NFPA 80.
 4. Between face of door and stop: 1/16 to 3/32 inch.
 - K. Manufacturing Tolerances: In accordance with SDI-117.
- 2.5 FINISHES
- A. Dress tool marks and surface imperfections to smooth surfaces.

- B. Clean and chemically treat steel surfaces.
- C. Touch up damaged metallic coatings.
- D. Apply manufacturer's standard rust inhibiting primer paint, air-dried or baked on, meeting requirements of ANSI/SDI A250.10.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

- A. Install doors and frames in accordance with ANSI/SDI A250.11.
- B. Set plumb and level.
- C. Secure to adjacent construction using fastener type best suited to application.
- D. Install hardware in accordance with Section 087100.

3.2 ADJUSTING

- A. Touch up minor scratches and abrasions in primer paint to match factory finish.

END OF SECTION

SECTION 083100 - ACCESS DOORS AND PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Custom floor access door at Pump House.

B. Related Sections:

1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 SUBMITTALS

A. Submittals for Review:

1. Shop Drawings: Provide sizes, types, finishes, and details of adjoining work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Floor Access Doors:

1. Source: Custom floor access door similar to this product:
(<https://www.etsy.com/listing/1732916589/custom-hatch-door-for-easy-cellar-and>)
2. Size: Refer to Drawings.
3. Material: Steel frame with wood flooring to match adjacent.
4. Hardware:
 - a. Heavy duty steel hinges.
 - b. Lock / Latch: Removable or recessed handle-operated cam latch for floor hatches.
 - c. Gas struts.

B. Steel:

1. Steel Sheet: ASTM A1008/A1008M, cold rolled.
2. Galvanized Steel Sheet: ASTM A653/A653M, Structural Quality.
3. Shapes: ASTM A36/A36M.
4. Tube: ASTM A500/A500M.

2.2 FABRICATION

- A. Weld, fill, and grind joints to flush and square appearance.

2.3 FINISHES

- A. Steel: Factory primed and painted.
- B. Wood: Finished to match adjacent wood flooring.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install units in accordance with manufacturer's instructions.
- B. Install plumb and level in openings. Secure rigidly in place.
- C. Position units where indicated or where required to provide convenient access to air handling unit below floor.

END OF SECTION

SECTION 08 71 00 - FINISH HARDWARE

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Work under this section comprises of furnishing hardware specified herein and noted on drawings for a complete and operational system, including any electrified hardware components, systems, controls and hardware for aluminum entrance doors. Any door shown on the drawing and not specifically referenced in the hardware sets shall be provided with identical hardware as specified on other similar openings and shall be included in the General Contractor's base bid. All fire rated door shall be provided with fire rated hardware as required by local code Authority as part of the General Contractor's base bid. The hardware supplier shall verify all cylinder types specified for locking devices supplied as part of the door system with the door manufacturer and/or door supplies.
- B. The General Contractor shall notify the Architect in writing of any discrepancies (five (5) days prior to bid date) that could and/or would result in hardware being supplied that is none functional, hardware specified and/or hardware that has not been specified that will result in any code violations and any door that is not covered in this specification. Failure of the General Contractor to address any such issue could be considered acceptance of the hardware specified and any and/or all discrepancies could be corrected at the General Contractor's expense.
- C. Items include but are not limited to the following:
1. Hinges - Pivots
 2. Flush Bolts
 3. Exit Devices
 4. Locksets and Cylinders
 5. Push Plates - Pulls
 6. Coordinators
 7. Closers
 8. Kick, Mop and Protection Plates
 9. Stops, Wall Bumpers, Overhead Controls
 10. Electrified Hold Open Devices
 11. Thresholds, Seals and Door Bottoms
 12. Silencers
 13. Miscellaneous Trim and Accessories
- 1.02 RELATED DOCUMENTS, drawings and general provisions of contract, including General and Supplementary Conditions, and Division 1 Specification sections, apply to this section.
- 1.03 RELATED WORK specified elsewhere that should be examined for its effect upon this section:
- A. Section 06 20 00 - Finish Carpentry
 - B. Section 08 11 13 – Steel Doors and Frames
 - C. Section 08 14 16 – Flush Wood Doors
 - D. Sections 08 31 13 – Access Doors

- E. Section 08 39 00 – Watertight Doors
- E. Section 08 41 13 – Aluminum Entrances, Storefront and Window Framing
- F. Sections 08 80 00 – Glass and Glazing
- G. Sections 09 91 00 - Painting
- H. Division 26 – Electrical
- I. Division 28 – Access Control

1.04 REFERENCES SPECIFIED in this section subject to compliance as directed:

- A. NFPA-80 - Standard for Fire Doors and Windows
- B. NFPA-101 - Life Safety Code
- C. ADA - The Americans with Disabilities Act - Title III - Public Accommodations
- D. ANSI-A 117.1 - American National Standards Institute - Accessible and Usable Buildings and Facilities
- E. ANSI-A 156.5 - American National Standards institute -Auxiliary Locks and Associated Products
- F. UFAS - Uniform Federal Accessibility Standards
- G. UL - Underwriter’s Laboratories
- H. WHI - Warnock Hersey International, Testing Services
- I. State and Local Codes including Authority Having Jurisdiction
- J. UL10C – Positive Pressure
- K. IBC-2021 – International Building Code
- L. NFPA-70 – International Electrical Code

1.05 SUBMITTALS

- A. HARDWARE SCHEDULES submit copies of schedule in accordance with Division 1, General Requirements. Schedule to be in vertical format, listing each door opening, including: handing of opening, all hardware scheduled for opening or otherwise required to allow for proper function of door opening as intended, and finish of hardware. At doors with door closers or door controls include degree of door opening. Supply the schedules all Finish Hardware within two (2) weeks from date purchase order is received by the hardware supplier.
- B. Submit manufacturer’s cut/catalog sheets on all hardware items and any required special mounting instructions with the hardware schedule.
- C. Certification of Compliance:
 - 1. Submit any information necessary to indicate compliance to these specifications as required.
 - 2. Submit a statement from the manufacturer that electronic hardware and systems being supplied comply with the operational descriptions exactly as specified.
- D. Submit any samples necessary as required by the Architect.
- E. Templates for finish hardware items to be sent to related door and frame suppliers within three (3) working days of receipt of approved hardware schedule.

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- F. Doors and Frames used in positive pressure opening assemblies shall meet UL10C in areas where this specification includes Seals for smoke door.
- 1.06 QUALITY ASSURANCE
- A. Hardware supplier to be a qualified, Factory Authorized, direct distributor of the products to be furnished. In addition, the supplier to have in their regular employment an AHC or AHC /CDC and/or a person of equivalent experience (minimum fifteen (15) years in the industry) who will be made available at reasonable times to consult with the Architect/Contractor and/or the Owners Representative regarding any matters affecting the finish hardware on this project.
- B. All hardware used in labeled fire or smoke rated openings to be listed for those types of openings and bear the identifying label or mark indicating UL. (Underwriter's Laboratories) approved for fire. Exit devices in non-labeled openings to be listed for panic.
- 1.07 DELIVERY, HANDLING AND PACKAGING
- A. Furnish all hardware with each unit clearly marked and numbered in accordance with the hardware schedule. Include door and item number for each.
- B. Pack each item of hardware completes with all necessary parts and fasteners.
- C. Properly wrap and cushion each item to prevent scratches and dents during delivery and storage.
- 1.08 SEQUENCING AND SCHEDULING
- Any part of the finish hardware required by the frame or door manufacturers or other suppliers that is needed to produce doors or frames is to be sent to those suppliers in a timely manner, so as not to interrupt job progress.
- 1.09 WARRANTY
- All finish hardware shall be supplied with a one- (1) year warranty against defects in materials and workmanship, commencing with substantial completion of the project except as follows:
1. All Closers shall have a thirty- (30) year written warranty.
 2. All Grade 1 and Grade 2 Locksets shall have a ten- (10) year written warranty.
 3. All Exit Devices shall have a ten (10) year written warranty.
 4. All Continuous Hinges shall have a life of installation written warranty.
- PART 2 – PRODUCTS
- 2.01 FASTENERS
- A. Furnish with finish hardware all necessary screws, bolts and other fasteners of suitable size and type to anchor the hardware in position for a long life under hard use.

- B. Furnish fastenings where necessary with expansion shields, toggle bolts and other anchors designated by the Architect according to the material to which the hardware is to be applied and the recommendations of the hardware manufacturer. All closers and exit devices on labeled wood doors shall be through-bolted if required by the door manufacturer. Where specified in the hardware sets, security type fasteners of the type called for are to be supplied.
- C. Design of all fastenings shall harmonize with the hardware as to material and finish.
- D. All hardware shall be installed with the Manufacturers standard screws as provided. The use of any other type of fasteners shall not be permitted. The general contractor shall provide wood blocking in all stud walls specified and/or scheduled to receive wall stops, No Exception.

2.02 ENVIRONMENTAL CONCERN FOR PACKAGING

The hardware shall ship to the job site is to be packaged in biodegradable packs such as paper or cardboard boxes and wrapping.

2.03 HINGES

- A. All hinges to be of one manufacturer as hereafter listed for continuity and consideration of warranty. Provide one of the following manufacturers Ives, Hager, Mc Kinney or Stanley.
- B. Unless otherwise specified provide five-knuckle, heavy-duty, button tip, full mortise template type hinges with non-rising loose pins. Provide non-removable pins for out swinging doors at secured areas or as called for in this specification (Refer to 3.02 Hardware Sets).
- C. Provide all out-swinging doors with non-removable pins or security studs as called for in 3.02 Hardware Sets. Furnish three (3) hinges up to 90 inches high and one (1) additional hinge for every 30 inches or fraction thereof.
- D. Furnish three (3) hinges up to 90 inches high and one (1) additional hinge for every 30 inches or fraction thereof.
- E. Provide size 4½" x 4½" for all 1¾" thick doors up to and including 36 inches wide. Doors over 1¾" through 2¼" thick, use 5" x 5" hinges. Doors over 36 inches use 5" x 4½" unless otherwise noted in 3.02 Hardware Sets.
- F. Were required to clear the trim and/or to permit the doors to swing 180 degrees furnish hinges of sufficient throw.
- G. Provide heavy weight hinges on all doors over 36 inches in width.
- H. At labeled door's stainless steel, bearing-type hinges shall be provided. For all doors equipped with closers provide bearing-type hinges.

2.04 LOCK AND LOCK TRIM

- A. All locksets, latch sets, and trim to be of one manufacturer as hereafter listed for continuity of design and consideration of warranty. Locksets specified are Schlage "ND" series with the Latitude levers.
- B. Provide metal wrought box strike boxes and curved lip strikes with proper lip length to protect trim of the frame, but not to project more than 1/8 inch beyond frame trim or the inactive leaf of a pair of doors.
- C. Mechanical Locks shall meet ANSI Operational Grade 1, Series 4000 as specified.
 - 1. Hand of lock is to be field reversible or non-handed.
 - 2. All lever trim is to be through-bolted through the door.
 - 3. All locks shall be field repairable without the purchase of a new locking device.
 - 4. All locks shall have the ability to change locking functions in the field without the purchase of a new locking device.

2.05 CYLINDERS AND KEYING

- A. Provide all exterior and interior locks or Exit Devices requiring cylinders keyed to the New Large Format Interchangeable Core Mater Key System as instructed by the Owners Representative. Cylinders shall comply with performance requirements of ANSI A156.5. All keys shall be of nickel silver material only. The hardware supplier shall meet with the General Contractor, the Architect and the Owners Representative at the project jobsite to determine all permanent keying requirements.
- B. Cylinders shall be factory keyed and factory maintained as directed by the owners Representative and the Architect. Provide two- (2) keys per cylinder and four- (4) master keys per master used.
- C. Factory stamp all keys "Do not duplicate" and with key symbol as directed by the Owners Representative. Visual key control shall be provided on all permanent keys and cylinders.
- D. Provide temporary keyed construction cores for the duration of the construction phase. Provide ten (10) construction keys and two (2) construction control keys. All construction cores shall be returned to the hardware supplier upon installation of permanent cores.

2.06 SURFACE MOUNTED DOOR CLOSERS

- A. All closers for this project shall be the products of a single manufacturer for continuity of design and consideration of warranty. All door closers shall be mounted as to achieve the maximum degree of opening (trim permitting).
- B. All closers to be heavy duty, surface-mounted, fully hydraulic, rack and pinion action with high strength case iron cylinder to provide control throughout the entire door opening and closing cycle.
- C. Size all closers in accordance with the manufacturer's recommendations at the factory.

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- D. All closers to have adjustable spring power sizes 1 or 2 through 4 or 6 and non-critical regulating screw valves for closing speed, latching speed and back-check control as a standard feature unless specified otherwise.
 - E. Provide closer covers only if provided as a standard part of the door closer package.
 - F. The hardware supplier shall provide all required brackets, spacers or filler plates as required by the manufacture for a proper and functional installation as part of their base bid.
 - G. Supply appropriate arm assembly for each closer so that closer body and arm are mounted on non-public side of door opening and on the interior side of exterior openings, except where required otherwise in the hardware sets.
 - H. Provide drop plates and any additional mounting brackets required for the proper installation of the door closer shall be included in the hardware supplier's base bid.
 - I. Finish: Baked on Powder Coated finish shall match other hardware.
 - J. Provide and mount all door closers with sex bolts as provided by the manufacturer.
 - K. Closers shall be LCN "4040XP" series as specified.
- 2.07 DOOR STOPS AND HOLDERS
- A. Door stops are to be furnished for every door leaf. Every door is to have a floor, wall, or an overhead stop.
 - B. Place doorstops in such a position that they permit maximum door swing, but do not present a hazard of obstruction. Furnish floor strikes for floor holders of proper height to engage holders of doors.
 - C. Where overhead stops and holders are specified, or otherwise required for proper door operation, they are to be heavy duty and of extruded brass, bronze or stainless steel with no plastic parts as specified. The General Contractor shall provide wood blocking in all stud walls specified and scheduled to receive wall stops.
 - D. Finish: Shall match other hardware where available.
 - E. Acceptable Products
 - 1. Floor and wall stops as listed in hardware sets. Equivalent products as manufactured by Ives, ABH and Trimco are acceptable.
- 2.08 PUSH PLATES, DOOR PULLS, AND KICKPLATES
- A. All push plates, door pull, kick plates and other miscellaneous hardware as listed in hardware sets. Equivalent products as manufactured by Ives, Hager and Trimco are acceptable.

- B. Kick plates to be 10 inches high and Mop plates to be 6 inches high, both by 1-½ inches or 1 inch less than door width (LDW) as specified. They are to be of 16-gauge thick base metal. For door with louvers or narrow bottom rails, kick plate height to be 1 inch less dimension shown from the bottom of the door to the bottom of the louver or glass.
- C. Where required armor plates, edge guards and other protective hardware shall be supplied in sizes as scheduled in the hardware sets.
- D. Finish: Same as other hardware where available.

2.09 FLUSH BOLTS AND COORDINATORS

- A. Provide Flush bolts with Dust Proof Strikes as indicated in the individual hardware sets by Ives, Hager and Trimco are acceptable. Finish shall match the adjacent hardware.

2.10 THRESHOLDS AND SEALS

- A. Provide materials and finishes as listed in hardware sets. Zero products have been specified to set a high level of quality, equivalent product by manufactured by National Guard Products and Pemko shall be acceptable. All thresholds must be in accordance with the requirements of the ADA and ANSI A117.1.
- B. Provide thresholds with Zero 226 stainless steel sleeve anchoring application. Supply all necessary anchoring devices as supplied by the product manufacturer for the installation of weather strip and sound seal.
- C. Seals shall comply with requirements of UL10C. All thresholds, door bottoms and weather strip inserts shall be a silicone based product as specified in 3.02 Hardware Sets. Other materials used shall be rejected, unless originally specified.
- D. Seals shall comply with the requirements of the Wood Door Manufacturer's certification requirements.
- E. Install all Threshold in a full bed of sealant as to prevent water & insect penetration inside of the building.

2.11 FINISHES

- A. Finishes for all hardware are as required in this specification and the hardware sets.
- B. Special care is to be taken to make uniform the finish of all various manufactured items.

2.12 DOOR SILENCERS

- A. Provide door silencers at all openings without gasket. Provide two- (2) each at pair of doors and three- (3) or four- (4) each for each single door (coordinate with the frame manufacturer).

2.13 PROPRIETARY PRODUCTS

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- A. References to specific products are used to establish quality standards of utility and performance. Unless otherwise approved provide only the specified product.
 - B. All other materials, not specifically described, but required for a complete and proper finish hardware installation, are to be selected by the Contractor, subject to the approval of the Architect and the Owners Representative.
 - C. Architect and the Owners Representative reserve the right to approve all the substitutions proposed for this specification. All requests for substitution to be made prior to bid in accordance with Division 1, General Requirements, and are to be in writing, hand delivered to the Architect. Two (2) copies of the manufacturer's brochures and a physical sample of each item in the appropriate design and finish shall accompany requests for substitution.

PART 3 - EXECUTION

3.01 INSTALLATION AND SERVICE ITEMS OF FINISH HARDWARE

- A. All finish hardware shall be installed by an experienced finish hardware installer with at least ten (10) years of experience after a pre-installation meeting between the contractor, hardware Manufacturers representative, the hardware supplier, the hollow metal supplier and the wood door supplier. The finish hardware installer shall be responsible for the proper installation and function of all doors and hardware.
- B. The hardware supplier's office and/or warehouse shall be located within a one seventy-five (75) mile radius of the project site as to better service the general contractor and the Owners Representative during this project.
- C. Check hardware against the reviewed hardware schedule upon delivery. Store the hardware in a dry and secure location to protect against loss and damage.
- D. Install finish hardware in accordance with approved hardware schedule and manufacturers' printed instructions. Pre-fit hardware before finish is applied to door; remove and reinstall after finish is complete and dry. Install and adjust hardware so that parts operate smoothly, close tightly, and do not rattle.
- E. Mortise and cutting to be done neatly, and evidence of cutting to be concealed in the finished work. Protect all Finish hardware from scratching or other damage.

3.02 HARDWARE SETS

Hardware Group No. 203

For use on Door #(s):

B104

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	B643E/ 716	IVE
1	EA	STOREROOM LOCK	ND80TD LAT	643e	SCH
1	EA	FSIC CORE	23-030	613	SCH
1	EA	WALL STOP	WS406/407CCV	643E/7 16	IVE
3	EA	SILENCER	SR64	GRY	IVE

Hardware Group No. 205IS

For use on Door #(s):

E101

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	B643E/ 716	IVE
1	EA	STOREROOM LOCK	ND80TD LAT	643e	SCH
1	EA	FSIC CORE	23-030	613	SCH
1	EA	OH STOP	100S (SIZE/MNT AS REQD)	643E/7 16	GLY
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ TBSRT	695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	613	IVE
1	EA	RAIN DRIP	142A DW + 4"	D	ZER
1	SET	JAMB SEAL	328D-2PC-JAMB HEIGHT	D	ZER
1	EA	HEADER SEAL	429D-1PC HEADER WIDTH	D	ZER
1	EA	DOOR SWEEP	39D-DOOR WIDTH	D	ZER
1	EA	THRESHOLD	655D-E-V3-226	D	ZER

Hardware Group No. 801

For use on Door #(s):

B102 B103

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	B643E/ 716	IVE
1	EA	PUSH PLATE	8200 4" X 16"	613	IVE
1	EA	PULL PLATE	8302 10" 4" X 16"	643E/7 16	IVE
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ TBSRT	695	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	613	IVE
1	EA	WALL STOP	WS406/407CCV	643E/7 16	IVE
3	EA	SILENCER	SR64	GRY	IVE

Hardware Group No. A804IL

For use on Door #(s):

D1 D2

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1HW 4.5 X 4.5	B643E/ 716	IVE
2	EA	MANUAL FLUSH BOLT	FB358 OR FB458 - TYPE AS REQ	613	IVE
1	EA	DUST PROOF STRIKE	DP1 OR DP2 - TYPE AS REQ	613	IVE
1	EA	CLASSROOM DEADBOLT	B663T 12-631	643E	SCH
4	EA	LONG DOOR PULL	9264 36" 24" STD	643E/7 16	IVE
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ TBSRT	695	LCN
1	EA	SURF. AUTO OPERATOR	9540 SERIES - MOUNT TO SUIT CONDITIONS	695	
1	EA	BOLLARD ACTUATOR	8310-3853TWB	AL	LCN
1	EA	ACTUATOR PKG	8310-3860T	630	LCN
1	EA	BOLLARD POST	8310-866 8310-853T 8310-801	AL	LCN
1	EA	MEETING STILE	53	DBZ	ZER
2	EA	DOOR SWEEP	39D-DOOR WIDTH	D	ZER
1	EA	THRESHOLD	655D-E-V3-226	D	ZER

Hardware Group No. G805IS

For use on Door #(s):

A101 A102 B101

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	B643E/ 716	IVE
1	EA	HIDDEN SHACKLE PADLOCK	TYPE AS DIRECTED BY OWNER	613	MAS
	EA	NOTE	REMAINDER OF HDWR BY GATE MANUFACTURER		

END OF SECTION

SECTION 088400 - ACRYLIC GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Acrylic panels.

B. Related Sections:

1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 SUBMITTALS

A. Submittals for Review:

1. Product Data: Descriptive data and performance attributes.
2. Samples:

- a. 12 x 12 inch acrylic samples.

3. Warranty: Sample warranty form.

B. Quality Control Submittals:

1. Test Report: Preconstruction adhesion and compatibility test report from glazing sealant manufacturer, based on submitted samples or acceptable data from previous testing of current formulations with similar products.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Minimum 3 years documented experience in work of this Section.

1.4 WARRANTIES

- A. Acrylic panels: Provide manufacturer's 5 year warranty against breakage, yellowing, and loss of abrasion resistance.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Acrylic Glazing:

1. ANSI Z97.1; ultraviolet stabilized, non-yellowing, abrasion resistant coated, refer to Drawings for colors.
2. Thickness: 1/4 inch.

3. Locations: At perforated metal panels.

2.2 ACCESSORIES

A. Glazing Gaskets:

1. Dense compression gaskets: ASTM C864, neoprene or EPDM, or ASTM C1115, silicone or thermoplastic polyolefin rubber, molded or extruded shape to fit glazing channel retaining slot; black color.
2. Soft compression gaskets: ASTM C509, Type II, black, molded or extruded, neoprene, EPDM, silicone or thermoplastic polyolefin rubber, of profile and hardness required to maintain watertight seal; black color.

- ### B. Glazing Sealant: ASTM C920, Type S, Grade NS, Class 25; single component silicone, low modulus, non sag, color to be selected from manufacturer's full color range.

- ### C. Sealant Backing: ASTM C1330, Type O, size and density to control glazing sealant depth and produce optimum glazing sealant performance.

- ### D. Primer: As recommended by glazing sealant manufacturer.

- ### E. Glazing Tape: AAMA 800; closed cell polyvinyl chloride foam, maximum 2 percent water absorption by volume, designed for 25 percent compression percent for air barrier and vapor retarder seal, black color, coiled on release paper over adhesive on two sides; widths required for installation.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean glazing rabbets; remove loose and foreign matter.
- B. Clean acrylic just prior to installation.

3.2 INSTALLATION - GENERAL

- A. Install acrylic panels in accordance with manufacturer's instructions.
- B. Maintain manufacturer's recommended edge and face clearances between acrylic and frame members.

3.3 INSTALLATION - GASKET GLAZING METHOD

- A. Fabricate gaskets to fit openings; allow for stretching of gaskets during installation.
- B. Set soft compression gasket against fixed stop or frame with bonded miter cut joints at corners.
- C. Set glass centered in openings on setting blocks.
- D. Install removable stops and insert dense compression gaskets at corners, working toward centers of glass, compressing glass against soft compression gaskets to produce weathertight seal.

- E. Seal joints in gaskets.
- F. Allow gaskets to protrude past face of glazing stops.

3.4 INSTALLATION - SEALANT AND TAPE GLAZING METHOD

- A. Apply tape to permanent stops, projecting slightly above sight line.
- B. Press glass into contact with tape.
- C. Install removable stops with spacer shims between stop and glass.
- D. Fill gap between removable stop and glass with glazing sealant.
- E. Trim protruding tape edges.

END OF SECTION

DIVISION 09

Finishes

95% Construction Documents

SECTION 09 03 20 – HISTORIC TREATMENT OF PLASTER

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. Repair and replacement of historic interior and exterior cementitious lime plaster.

B. Related Requirements:

1. Section 01 35 91 - Historic Treatment Procedures for general historic treatment requirements.
2. Section 03 03 01 - Historic Cast-in-place Concrete Cleaning for cleaning, paint removal, and surface preparation for cast-in-place concrete features that support lath and plaster.
3. Section 04 03 10 - Historic Masonry Cleaning for cleaning, paint removal, and surface preparation for masonry features that support lath and plaster.
4. Section 04 03 42 - Historic Masonry Repair and Repointing for repair and repointing masonry features that support lath and plaster.
5. Section 08 03 51 - Historic Treatment of Steel Windows for repair and reglazing of steel windows anchored in masonry and plaster materials.
6. Section 09 03 91 - Historic Treatment of Plain Painting for paint removal, surface preparation for refinishing, and refinishing of historic plaster surfaces.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review minutes of Preliminary Historic Treatment Conference that pertain to historic treatment of plaster.
2. Review methods and procedures related to historic treatment of plaster including, but not limited to, the following:
 - a. Verify historic treatment specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, material application, colors, patterns, and sequencing.
 - c. Fire-protection plan.
 - d. Plasterwork historic treatment program.
 - e. Coordination with building occupants.

1.4 SEQUENCING AND SCHEDULING

A. Perform historic treatment of plaster in the following sequence, which includes work specified in this and other Sections:

1. Coordinate treatments of historic plaster with work to adjacent historic features and materials such as historic masonry cleaning and repairs, historic window and door repair and reglazing, and repainting of adjacent surfaces.
2. Dismantle existing surface-mounted objects and hardware that overlie plaster surfaces except items indicated to remain in place. Tag items with location identification and protect.
3. Verify that temporary protections have been installed.
4. Examine condition of plaster surfaces.
5. Remove all delaminating and failing plaster from substrate.
6. Remove and replace all corroded and damaged metal supports, lath, furring, corner beads and fasteners.

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7. Clean plaster surface and remove paint and other finishes to the extent required.
 8. Repair and replace existing plaster and supports to the degree required for a uniform, tightly adhered surface on which to paint or apply other finishes.
 9. Cure repaired surfaces and allow them to dry for proper finishing.
 10. Paint and apply other finishes.
 11. Reinstall dismantled surface-mounted objects and hardware unless otherwise indicated.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include recommendations for product application and use.
- B. Shop Drawings: For each configuration of new or replicated plaster features and details required for the work.
 1. Include plans, elevations, and sections that show locations and extent of work.
 2. Show full-size details of configurations, joint locations, and attachments to other work.
 3. Show full-size details of chamfered exterior and interior window sills.
 4. Show full-size details of corner beading at column furr-outs, exterior and interior wall corners, and window and door surrounds.
- C. Samples for Initial Selection: For each exposed product that will be exposed and not be painted or otherwise finished and for each color and texture specified.
- D. Samples for Verification: For the following products:
 1. Linear Moldings: 24-inch- ((610-mm-))long section of each configuration wet-applied molding with finished joint. Show complete pattern and applied nonlinear cast-plaster shapes, if any.
 2. Nonlinear Shapes: Full-size unit of each configuration.
 3. Wood Lath: 18-inch- ((450-mm-))long section.
 4. Metal Lath: 18 inches ((450 mm))square.
 5. Accessories: Each type in manufacturer's standard size.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified historic treatment specialist.
- B. Plasterwork Historic Treatment Program: Submit before work begins.

1.7 QUALITY ASSURANCE

- A. Historic Treatment Specialist Qualifications: A qualified historic plastering specialist with seven or more years of demonstrated expertise in matching and performing the types of historic plasterwork repairs required. Experience only in installing and repairing new plasterwork, veneer plaster, or gypsum board is insufficient experience for historic treatment work.
- B. Plasterwork Historic Treatment Program: Prepare a written, detailed description of materials, methods, equipment, and sequence of operations to be used for historic treatment work and protection of surrounding materials and Project site.
 1. Include methods and procedures to protect plastered surfaces from damage caused by construction operations, including, but not limited to, exposure to moisture, vibration, mechanical damage, and soiling.
 2. If materials and methods other than those indicated are proposed for any phase of historic treatment work, add a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project.
- C. Mockups: Prepare mockups of historic treatment processes for each type of plaster repair and reconstruction work to demonstrate aesthetic effects and to set quality standards for materials and execution and for fabrication and installation.
 1. Locate mockups on existing surfaces where directed by Historic Architect in locations that enable viewing under same conditions as the completed Work.

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2. Number and Size: Two wall surfaces of at least 50 sq. ft. or approximately 48 inches in least dimension to represent surfaces and conditions for application of each type of plaster repair and reconstruction under same conditions as the completed Work. Include at least the following:
 - a. Install 4-sq. ft. area of wet-applied plaster replacement.
 - b. Patch 10-sq. ft. area of wet-applied plaster replacement.
 - c. Install 6 linear ft. of wet-applied plaster replacement at exterior and interior window sills with texture pattern to match historic pattern.
 - d. Repair 3 linear ft. of plaster cracks.
 - e. Reattach 4-sq. ft. area of delaminated plaster that has not fallen.
 3. Simulate finished lighting conditions for review of mockups.
 4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 5. 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 packaged materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.
- B. Store materials on elevated platforms, under cover, and in a dry location with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
- C. Store hydrated lime and factory-prepared lime putty in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two days.
- D. Store materials not in use in tightly covered containers.
- E. Store lime putty covered with water in sealed containers.
- F. Store sand where grading and other required characteristics can be maintained and contamination avoided.

1.9 FIELD CONDITIONS

1. Comply with plaster-material manufacturers' written instructions.
2. Temperatures: Maintain temperatures in work areas at not less than 55 deg F (13 deg C) or greater than 80 deg F (27 deg C) for at least seven days before application of plaster, continuously during application, and for seven days after plaster has set or until plaster has dried.
3. Conditioning: Acclimatize cast-plaster fabrications to ambient temperature and humidity of spaces in which they are installed. Remove packaging and move units into installation spaces not less than 48 hours before installing them.
4. Field Measurements: Where cast-plaster fabrications are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
5. Avoid conditions that result in plaster drying out too quickly.
6. Distribute heat evenly; prevent concentrated or uneven heat on plaster.
7. Maintain relative humidity levels for prevailing ambient temperature that produce normal drying conditions.
8. Ventilate work areas in a manner that prevents drafts of air from contacting surfaces during plaster application and until plaster is dry.

PART 2 - PRODUCTS

2.1 LIME-PLASTER MATERIALS

- A. Hydrated Lime: ASTM C 206, Type S or Type N.
- B. Lime Putty: Slaked hydrated lime or factory-prepared lime putty according to ASTM C 1489.
- C. Sand Aggregates: ASTM C 897.
 - 1. Finish-Coat Sand: Match size, texture, and gradation of existing sand as closely as possible. Blend several sands if necessary to achieve suitable match.
- D. Pigments for Colored Plaster: ASTM C 979/C 979M and having a record of satisfactory performance in lime plaster.
- E. Fiber: 1/2 to 1 inch (13 to 25 mm) in length; composed of alkali-resistant glass or polypropylene fiber, free of grease, waxes, and oils; and beaten well to separate fibers before blending into unfibered plaster material.
 - 1. Proportion of Fiber to Unfibered Plaster Material: 3.5 oz./cu. ft. of unfibered plaster material, adjusted as required to produce a well-fibered, cohesive, spreadable, stiff mix with fibers uniformly distributed.
- F. Fabric Reinforcing: Coarse, open-weave, alkali-resistant fiberglass or polypropylene fabric; free of grease, waxes, and oils. Utilize fabric reinforcing only where galvanized metal lath cannot be employed due to existing physical constraints or evidence of structural movement to substrate materials.

2.2 LATH

- A. Metal Lath:
 - 1. Expanded-Metal Lath: ASTM C 847, cold-rolled carbon-steel sheet, ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coated.
 - a. Diamond-Mesh Lath: Self-furring, 2.5 lb/sq. yd. or 3.4 lb/sq. yd., depending on application and substrate materials.

2.3 TRIM ACCESSORIES

- A. General: According to ASTM C 1063 for lime plaster, coordinate depth of trim and accessories with thicknesses and number of plaster coats required.
- B. Metal Accessories:
 - 1. Cornerite: Fabricated from expanded-metal lath with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
 - 2. Striplath: Fabricated from expanded-metal lath with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
 - 3. Cornerbeads: Fabricated from zinc or zinc-coated (galvanized) steel.
 - a. Match existing cornerbead profiles, unless otherwise indicated.
 - b. Small nose cornerbead with expanded flanges.
 - c. Small nose cornerbead with perforated flanges; use on curved corners.
 - d. Small nose cornerbead with expanded flanges reinforced by perforated stiffening rib; use on columns and for finishing unit masonry corners.
 - e. Bull nose cornerbead, radius of 3/4 inch (19 mm) minimum, with expanded flanges; use at locations indicated on Drawings.
 - 4. Casing Beads: Fabricated from zinc or zinc-coated (galvanized) steel; square-edged style; with expanded flanges.
 - 5. Control Joints: Fabricated from zinc or zinc-coated (galvanized) steel; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
 - 6. Expansion Joints: Fabricated from zinc or zinc-coated (galvanized) steel; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.

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7. Two-Piece Expansion Joints: Fabricated from zinc or zinc-coated (galvanized) steel; formed to produce slip-joint and square-edged reveal that is adjustable from 1/4 to 5/8 inch (6 to 16 mm) wide; with perforated flanges.
- 2.4 Insert other accessories or accessories made of other materials here.
- 2.5 MISCELLANEOUS MATERIALS
- A. Water for Mixing and Finishing Plaster: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
- B. Fasteners for Attaching Lath to Substrates:
1. For Lime Plaster: ASTM C 1063.
- C. Wire Ties: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, not less than 0.0475-inch (1.21-mm) diameter, unless otherwise indicated.
- D. Plaster-Stabilization Materials: Acrylic emulsion(s) and related installation products shall have proven effectiveness in reattaching delaminated plaster and shall have been used previously by historic treatment specialist with successful results.
1. Acrylic Emulsion(s), General: Aqueous emulsion(s) of acrylic polymer, adhesive to plaster and plaster substrates, nontoxic, and non-reemulsifiable after curing.
 2. Prewet Solution: Low-viscosity acrylic emulsion.
 3. Adhesive: Thickened acrylic emulsion; thickener as recommended in writing by resin manufacturer and historic treatment specialist.
- E. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:
1. Previous effectiveness in performing the work involved.
 2. Little possibility of damaging exposed surfaces.
 3. Consistency of each application.
 4. Uniformity of the resulting overall appearance.
 5. Do not use products or tools that could do the following:
 - a. Remove, alter, or in any way harm the present condition or future preservation of existing surfaces, including surrounding surfaces not in contract.
 - b. Leave an unintended residue on surfaces.

PART 3 - EXECUTION

- 3.1 HISTORIC TREATMENT OF PLASTER, GENERAL
- A. Historic Treatment Appearance Standard: Completed work is to have a uniform appearance as viewed by Preservation Architect from building interior at 5 feet away from surface and from building exterior at 20 feet away from surface.
- B. General: In treating historic plaster, disturb it as minimally as possible and as follows unless otherwise indicated:
1. Dismantle loose, damaged, or deteriorated plaster, lath, and support systems that cannot be repaired.
 2. Verify extent of plaster deterioration against that indicated on Drawings. Consult Architect on types and extent of required work.
 3. Verify that substrate surface conditions are suitable for repairs.
 4. Provide lath, furring, and support systems for plaster included in the work of this Section.
 5. Replace lost details in new, wet-applied and cast plaster that replicate existing or indicated plaster configurations.
 6. Leave repaired plasterwork in proper condition for painting or applying other finishes as indicated.
 7. Install temporary protective measures to protect historic surfaces that shall be treated later.

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- C. Illumination: Perform plastering work with adequate, uniform illumination that does not distort the flatness or curvature of surfaces.
- 3.2 EXAMINATION
- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate and environmental conditions, installation tolerances, and other conditions affecting performance of the Work.
1. If existing substrates cannot be prepared to an acceptable condition for plastering work, notify Architect in writing.
 2. Notify Preservation Architect of undocumented detrimental conditions including cracks, bulges, loose backup, rotted wood, rusted metal, and other deteriorated items.
- B. Masonry Substrates: Verify that mortar joints are struck flush. Notify Preservation Architect of undocumented masonry substrate without flush joints, or deterioration or cleaning conditions not properly prepared through historic masonry treatment procedures. Proceed with plastering as directed by Preservation Architect.
- C. Begin historic plastering work only after unsatisfactory conditions have been corrected.
- 3.3 PREPARATION FOR PLASTERING
- A. Substrates: Prepare according to plaster manufacturer's written instructions and as follows:
1. Clean surfaces to remove dust, loose particles, grease, oil, incompatible curing compounds, form-release agents, and other foreign matter and deposits that could impair bond with plaster.
 2. Remove ridges and protrusions greater than 1/8 inch (3 mm) and fill depressions greater than 1/4 inch (6 mm) with patching material. Allow to set and dry.
- 3.4 PLASTER REMOVAL AND REPLACEMENT, GENERAL
- A. Dismantle plaster that is damaged or deteriorated to the limits indicated. Carefully dismantle areas along straight edges that lie over supports, without damaging surrounding plasterwork.
- B. Maintain lath and supporting members in an undamaged condition so far as practicable. Dismantle damaged lath and supports that cannot be repaired or resecured and replace with new work of same type.
- C. Notify Architect of undocumented detrimental conditions including cracks, bulges, loose backup, rotted wood, rusted metal, and other deteriorated items.
- D. Do not deviate more than plus or minus 1/8 inch in 10 feet (3 mm in 3 m) from a true plane in finished plaster surfaces, as measured by a 10-foot (3-m) straightedge placed on surface.
- E. Clean substrate surfaces to remove grease, waxes, oils, waterborne staining, debris, and other foreign matter and deposits that could impair bond with repair material.
- F. Wet masonry and concrete bases before plaster application. Keep substrate damp to the touch but without visible water droplets.
- G. Wet remaining plaster abutting the replacement plaster before installing new plasterwork.
- H. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
- I. Provide plaster surfaces that are ready to receive field-applied finishes indicated.
- 3.5 FLAT LIME-PLASTER REMOVAL AND REPLACEMENT <Insert drawing designation>
- A. General: Dismantle deteriorated plaster to existing sound plaster.
- B. Inspect for lath deterioration. If any, replace lath.
1. Sand bonding surfaces of repair area, and clean the surface with a nonmetallic bristle brush.
 2. Wet substrate to damp condition, but without visible water droplets, then install new plaster to original profiles.
- C. Lime-Plaster Base Coats:

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1. Scratch Coat: 1 part lime putty, 2-1/2 parts base-coat sand, and fiber. Add hair fiber to mix and evenly distribute it without clumps just before spreading.
 2. Brown Coat: 1 part lime putty, 3 parts base-coat sand.
- D. Lime-Plaster Finish Coats:
1. Finish-Coat Mix for Smooth-Troweled Finish: 3 parts lime putty, 1 part finish-coat sand.
 2. Finish-Coat Mix for Smooth-Float Finish: 1 part lime putty, 1 part finish-coat sand.
 3. Finish-Coat Mix for Sandy Float Finish: 1 part lime putty, 3 parts finish-coat sand.
- E. Lime-Plaster Finishes: Match finish(es) of design reference sample(s).
1. Provide smooth-troweled finish where indicated. Apply in three layers totaling 3/16 inch thick.
 2. Provide smooth-float finish unless otherwise indicated. Apply in three layers totaling 3/16 inch thick.
 3. Provide sandy-float finish where indicated. Apply in three layers totaling 3/16 inch thick.
- F. Hairline cracking within the plaster or plaster separation at edge of a replacement is unacceptable. Completely dismantle such work and reinstall or repair as a crack repair.

3.6 REMOVING AND INSTALLING LATH AND ACCESSORIES

- A. General: Dismantle existing plaster as necessary to expose deteriorated or rusted lath, wire ties, and support system, back to firm substrates and supports. Repair with new materials, well secured to existing lath in good condition and to building structure.
1. Cutting: Cut lath so it can be taken out completely from one support to the next. Cut to avoid cracking surrounding plaster.
 2. Cut out existing base-coat plaster beyond the edges of the new lath to permit new plaster to extend onto the old lath. Then step subsequent plaster coats to permit new plaster to extend over the old material.
 3. Fasten new lath to support system and to good existing lath. Wire tie at least every 6 inches (150 mm).
 4. Install new lath according to ASTM C 1063 for lime plaster.
- B. Notify Architect of undocumented detrimental conditions including cracks, bulges, loose backup, rotted wood, rusted metal, and other deteriorated items.
- C. Wood Lath: Install wood lath in same orientation and spacing as remaining wood lath and with lath ends supported by furring or framing. Stagger ends of adjacent laths over different supports, not aligned, and secure with fasteners at each end and spaced a maximum of 24 inches (610 mm) o.c. into supports.
- D. Metal Lath: Install according to ASTM C 1063 for lime plaster.
1. Partition Framing and Vertical Furring: Install flat diamond-mesh lath.
 2. Flat-Ceiling and Horizontal Framing: Install flat diamond-mesh lath.
 3. On Solid Surfaces, Not Otherwise Furred: Install self-furring, diamond-mesh lath.

3.7 PATCH-TYPE REPAIR <Insert drawing designation>

- A. General: Patch voids, fractured surfaces, and crushed areas in otherwise sound plaster that are larger than cracks.
1. Notify Preservation Architect of undocumented detrimental conditions including cracks, bulges, loose backup, rotted wood, rusted metal, and other deteriorated items.
 2. Inspect for deterioration of supporting plaster and lath, and repair or replace deteriorated material as required for a sound substrate.
 3. Rake perimeter of hole to sound plaster, and slightly undercut existing plaster to enable replacement plaster to tuck behind existing plaster.
 4. Replace missing lath in kind. Bridge gaps in wood lath with expanded-metal lath, overlapping wood by 6 inches (150 mm) and fastening them together.
 5. Clean hole to remove loose materials and other foreign matter and deposits that could impair bond with repair material. Where grease, waxes, oils, waterborne staining, or other foreign

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- matter and deposits that could impair bond with repair material have penetrated into the plaster, enlarge the hole to remove these deposits.
6. Wet substrate to damp condition, but without visible water droplets, then install patch material to original profiles.
 7. Maintain adjacent plasterwork in an undamaged condition so far as practicable.
- B. Lime-Plaster Mix: Repair mix demonstrated in mockup.
- C. Finishing: Finish flat surfaces flush and with same texture as adjacent existing plaster.
- D. Hairline cracking within the plaster or plaster separation at edge of a patch is unacceptable. Completely dismantle such work and reinstall or repair.
- 3.8 HAIRLINE CRACK REPAIR <Insert drawing designation>
- A. General: Repair cracks 1/32 inch in width or narrower in otherwise sound plaster.
 1. Notify Preservation Architect of undocumented detrimental conditions including cracks, bulges, loose backup, rotted wood, rusted metal, and other deteriorated items.
 2. Maintain adjacent plasterwork in an undamaged condition so far as practicable.
 - B. Existing Topcoat: Open crack in existing topcoat to at least 1/8 inch in width and check for broken fiber reinforcement in base coats.
 - C. Existing Base Coats: Do not open crack wider in existing base coats unless inspection or other indication shows that the fiber reinforcement has broken. Where inspections indicate failure of fiber reinforcement, proceed as for a large crack repair, but only for length of crack with broken fiber reinforcement.
 - D. Clean out crack to remove loose materials and other foreign matter and deposits that could impair bond with repair material. Where grease, waxes, oils, waterborne staining, or other foreign matter and deposits that could impair bond with repair material have penetrated into the topcoat plaster, widen the crack and sand surface of the exposed basecoat to remove these deposits.
 - E. Wet substrate to damp condition, but without visible water droplets.
 - F. Force repair material demonstrated in mockup into crack, filling crack to original plaster profile.
 - G. Finishing: Finish flat surfaces flush and with same texture as adjacent existing plaster. For molded plaster shapes, tool surface to restore the sharp edges and the shape of the molded shape to original contours.
- 3.9 LARGE CRACK REPAIR <Insert drawing designation>
- A. General: Repair cracks over 1/32 inch in width in otherwise sound plaster.
 1. Notify Preservation Architect of undocumented detrimental conditions including cracks, bulges, loose backup, rotted wood, rusted metal, and other deteriorated items.
 2. Maintain adjacent plasterwork in an undamaged condition so far as practicable.
 - B. Open crack to at least 1/8 inch in width and full depth with V-groove tool, and check for bond separation or lath deterioration.
 - C. Abrade side surfaces of crack and remove inner crack debris by gouging (keying) the inside area of the crack.
 - D. Clean out crack to remove loose materials and other foreign matter and deposits that could impair bond with repair material. Where grease, waxes, oils, waterborne staining, or other foreign matter and deposits that could impair bond with repair material have penetrated into the plaster, widen the crack to remove these deposits.
 - E. Wet substrate to damp condition, but without visible water droplets.
 - F. Install repair material demonstrated in mockup to fill crack to original plaster profile.
 - G. Finishing: Finish flat surfaces flush and with same texture as adjacent existing plaster. For molded plaster shapes, tool surface to restore the sharp edges and the shape of the molded shape to original contours.
 - H. Offset Cracks: If the crack is offset in surface plane by more than 1/8 inch, dismantle the plaster on each side of the crack, a minimum width of 6 inches and down to the lath or other substrate. Then, repair as specified for flat-plaster removal and replacement.

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- 3.10 REATTACHMENT OF DELAMINATED PLASTER <Insert drawing designation>
- A. General: Reattach plaster that has detached from its metal lath or masonry substrate.
 - 1. Notify Preservation Architect of undocumented detrimental conditions including cracks, bulges, loose backup, rotted wood, rusted metal, and other deteriorated items.
 - 2. Maintain adjacent plasterwork in an undamaged condition so far as practicable.
 - B. Verify extent of detachment of plaster that has not yet fallen by tapping on plaster surface and evaluating the hollow or solid resonance.
 - C. Protect floors from spillage and debris in the vicinity of work. Use materials resistant to the passage of fluids used in work.
 - D. Drill 1/4-inch (6-mm) injection ports (holes) through the plaster spaced 3 to 6 inches (75 to 150 mm) apart over surface of detached plaster. Dislodge loose plaster particles, and vacuum debris from holes.
 - E. Prewet injection ports, gaps at edges of lost plaster, back of plaster, and wooden lath with prewet solution.
 - F. Inject adhesive into ports, enough to fill gaps between detached plaster and lath, and inject into gaps at edges of lost plaster.
 - G. Clean off excess and smeared adhesive while wet.
 - H. Apply temporary battens over surface of treated plaster to prevent further separation during repair work. Secure battens in place against plaster with screws through the battens and plaster and into the metal lath or masonry substrate.
 - I. Maintain temporary battens in place for a week or more, allowing adhesive to coalesce and dry.
 - J. Remove battens, patch holes and missing plaster, and repair cracks.
- 3.11 INSTALLATION TOLERANCES
- A. Completed plaster installation shall not deviate from a true plane by more than 1/8 inch as measured by a 5-foot (1.5-m) straightedge placed at any location on a surface, except where existing plaster is retained as a substrate for new plasterwork.
- 3.12 CLEANING AND PROTECTION
- A. Protect work of other trades against damage. Promptly remove plaster from surfaces not indicated to be repaired or plastered. Do not scratch or damage finished surfaces.
 - B. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.
 - C. Correct damage to other historic surfaces and to new work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
 - D. Remove temporary protection and enclosure of other work.

END OF SECTION 09 03 20

SECTION 09 03 91 – HISTORIC TREATMENT OF PLAIN PAINTING

PART 1 - GENERAL

A. RELATED DOCUMENTS

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 historic treatment of plain painting as follows:

1. Removing existing paint.
2. Repairing substrates.
3. Plain painting of historic surfaces, including staining and varnishing of historic wood].

B. Painting newly replicated or replacement wood components to be integrated into the historic facades.

C. Related Requirements:

1. Section 01 35 91 - Historic Treatment Procedures for general historic treatment requirements.

1.3 UNIT PRICES

A. Work of this Section is affected by unit prices specified in Section 012200 "Unit Prices."

1. Unit prices apply to authorized work covered by quantity allowances.
2. Unit prices apply to authorized additions to and deletions from Work as authorized by Change Orders.

1.4 DEFINITIONS

A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

B. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

C. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

D. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

E. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

F. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

G. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

H. Historic Paint Materials: Paint materials manufactured to match historic paint formulations; either custom-formulated products or standard products of manufacturers of historic paint materials.

I. Modern Paint Materials: Paint materials not designed to match historic paint formulations but that may be required to match historic paint colors.

J. Plain Painting: For historic treatment, this means painting that requires attention to historic treatment requirements, but no special, decorative or artistic painting skill.

K. Low-Pressure Spray: 100 to 400 psi (690 to 2750 kPa); 4 to 6 gpm (0.25 to 0.4 L/s).

L. Medium-Pressure Spray: 400 to 800 psi (2750 to 5510 kPa); 4 to 6 gpm (0.25 to 0.4 L/s).

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

B. Review minutes of Preliminary Historic Treatment Conference that pertain to historic treatment of painting.

1. Review methods and procedures related to historic treatment of painting including, but not limited to, the following:
- C. Verify historic treatment specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 1. Materials, material application, colors, patterns, and sequencing.
 2. Fire-protection plan.
 3. Plain painting historic treatment program.
 4. Coordination with building occupants.

1.6 SEQUENCING AND SCHEDULING

- A. Perform historic treatment of painting in the following sequence, which includes work specified in this and other Sections:
- B. Dismantle existing surface-mounted objects and hardware except items indicated to remain in place. Tag items with location identification and protect.
 1. Verify that temporary protections have been installed.
 2. Examine condition of surfaces to be painted.
 3. Remove existing paint to the degree required for each substrate and surface condition of existing paint.
 4. Apply paint system.
 5. Reinstall dismantled surface-mounted objects and hardware unless otherwise indicated.

1.7 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Include recommendations for product application and use. Include test data substantiating that products comply with requirements.
- C. LEED Submittals:
- D. Product Data for Credit IEQ 4.2: For paints and coatings, documentation including printed statement of VOC content.
 1. Laboratory Test Reports for Credit IEQ 4.2: For paints and coatings, documentation indicating that products comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- E. Samples: For each type of paint system and each pattern, color, and gloss; minimum 6 inches (150 mm) long in least dimension, but not less than whole pattern.
- F. Include stepped Samples defining each separate coat, including fillers and primers. Resubmit until each required sheen, color, and texture is achieved.
 1. For each painted color being matched to a standardized color-coding system, include the color chips from the color-coding-system company with Samples.
 2. Include a list of materials for each coat of each Sample.
 3. Label each Sample for location and application.
 4. Sample Size:
 - a. Plain Painted Surfaces: 4-by-8-inch (100-by-200-mm) Samples for each color and material, on hardboard.
 - b. Stained or Natural Wood: 12-by-12-inch (300-by-300-mm) Samples of natural- or stained-wood finish, on representative matching species of wood surfaces.
- G. Product List: For each paint product indicated, include the following:

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- H. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
 - 1. Printout of current MPI's "MPI Approved Products List" for each MPI-product category specified in paint systems, with the proposed product highlighted.
 - 2. VOC content.
- 1.8 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For paint-remover manufacturer.
 - B. Plain Painting Historic Treatment Program: Submit before work begins.
 - C. Color Matching Certificate: For computer color matching of historic colors.
 - D. Preconstruction Test Reports: For cleaning materials, paint removers and paint coatings and systems.
- 1.9 MAINTENANCE MATERIAL SUBMITTALS
- A. Furnish extra paint materials, from the same production run, that match products applied and that are packaged with protective covering for storage and identified with labels describing contents, including material, finish, source, and location on building.
 - 1. Quantity: Furnish Owner with an additional 5 percent, but not less than 1 gal. (3.8 L) or one case, as appropriate, of each material and color applied.
- 1.10 QUALITY ASSURANCE
- A. Historic Treatment Specialist Qualifications: A qualified historic painting specialist with expertise in matching and touching up existing painting. Experience only in new painting work is insufficient experience for historic treatment work.
 - B. Paint-Remover Manufacturer Qualifications: A firm regularly engaged in producing paint removers that have been used for similar historic painting applications with successful results, and with factory-authorized service representatives who are available for consultation and Project-site inspection and on-site assistance.
 - C. Color Matching: Custom computer-match paint colors to colors indicated For colors indicated by a standardized coding system, obtain a color chip for each color indicated from the color-coding-system company; computer match paint colors to the color chips.
 - D. Plain Painting Historic Treatment Program: Prepare a written, detailed description of materials, methods, equipment, and sequence of operations to be used for historic treatment work, including protection of surrounding materials and Project site and control of runoff during cleaning, paint removal, repainting, and other processes.
 - E. If materials and methods other than those indicated are proposed for any phase of historic treatment work, add a written description of such materials and methods, including evidence of successful use on comparable projects, and demonstrations to show their effectiveness for this Project.
 - F. Mockups: Prepare mockups of historic treatment processes for each type of coating system and substrate indicated and each color and finish required to demonstrate aesthetic effects and to set quality standards for materials and execution. Duplicate appearance of approved Sample submittals.
 - 1. Locate mockups on existing surfaces where directed by Architect.
 - 2. Surface-Preparation Mockups: On existing surfaces using applicable specified methods of cleaning and other surface preparation, provide mockup sample of at least 100 sq. ft. (9 sq. m).
 - 3. Coating Mockups: Two wall surfaces of at least 100 sq. ft. (9 sq. m) to represent surfaces and conditions for application of each type of coating system under same conditions as the completed Work.
 - G. Plain painted surfaces.
 - 1. Stained or natural wood.
 - H. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

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1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- 1.11 PRECONSTRUCTION TESTING
 - A. Preconstruction Testing Service: Engage a qualified historic treatment specialist to perform preconstruction testing of cleaning materials, paint removers and compatibility of paint coatings and systems for each indicated type of historic painted surface.
 - B. Use test areas as indicated and representative of proposed materials and existing construction.
 1. Propose changes to materials and methods to suit Project.
 - 1.12 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).
 - B. Maintain containers in clean condition, free of foreign materials and residue.
 1. Remove rags and waste daily.
 - 1.13 FIELD CONDITIONS
 - A. Weather Limitations: Proceed with historic treatment of painting only when existing and forecasted weather conditions are within the environmental limits set by each manufacturer's written instructions and specified requirements.
 - B. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
 - C. Do not apply paint 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.
 - D. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer for surface preparation and during paint application and drying periods.
 - E. Concealed and undocumented historic items, murals, and similar objects encountered during historic treatment remain Owner's property. Carefully protect each item or object.
 1. Coordinate with Owner's Historic Architect, who will establish special procedures for protection.

PART 2 - PRODUCTS

- 2.1 PREPARATORY CLEANING MATERIALS
 - A. Water: Potable.
 - B. Hot Water: Water heated to a temperature of 140 to 160 deg F (60 to 71 deg C).
 - C. Detergent Solution: Solution prepared by mixing 2 cups (0.5 L) of tetrasodium pyrophosphate (TSPP), 1/2 cup (125 mL) of laundry detergent that contains no ammonia, 5 quarts (5 L) of 5 percent sodium hypochlorite bleach, and 15 quarts (15 L) of warm water for every 5 gal. (20 L) of solution required.
 - D. Mildewcide: Commercial proprietary mildewcide or a job-mixed solution prepared by mixing 1/3 cup (80 mL) of household detergent that contains no ammonia, 1 quart (1 L) of 5 percent sodium hypochlorite bleach, and 3 quarts (3 L) of warm water.
 - E. Abrasives for Ferrous Metal Cleaning: Aluminum oxide paper, emery paper, fine steel wool, steel scrapers, and steel-wire brushes of various sizes.
 - F. Rust Remover: Manufacturer's standard phosphoric acid-based gel formulation, also called "naval jelly," for removing corrosion from iron and steel.

2.2 PAINT REMOVERS

- A. Alkaline Paste Paint Remover: Manufacturer's standard alkaline paste or gel formulation for removing paint from masonry, stone, wood, plaster, or metal as required to suit Project; and containing no methylene chloride.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABR Products, Inc.; 800 Brush Grade.
 - b. Diedrich Technologies Inc., a division of Sandell Construction Solutions; 606 Multi-Layer Paint Remover or 606X Extra Thick Multi-Layer Paint Remover.
 - c. EaCo Chem, Inc.; Stripper Cream.
 - d. Hydrochemical Techniques, Inc.; HydroClean HT-716 Heavy Duty Paint Remover.
 - e. PROSOCO, Inc.; Sure Klean Heavy-Duty Paint Stripper or Sure Klean Heavy-Duty Paint Stripper D.
 - f. Shore Corporation; 2200 Alka Strip.
- B. Covered or Skin-Forming Alkaline Paint Remover: Manufacturer's standard covered or skin-forming alkaline paste or gel formulation for removing paint from masonry, stone, wood, plaster, or metal as required to suit Project; and containing no methylene chloride.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABR Products, Inc.; 800 Fast Acting Grip 'N Strip.
 - b. Diedrich Technologies Inc., a division of Sandell Construction Solutions; 404 Rip-Strip.
 - c. Dumond Chemicals, Inc.; Peel Away 1.
- C. Solvent-Type Paste Paint Remover: Manufacturer's standard water-rinsable, solvent-type paste or gel formulation for removing paint from masonry, stone, wood, plaster, or metal as required to suit Project.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Diedrich Technologies Inc., a division of Sandell Construction Solutions; 505 Special Coatings Stripper.
 - b. Hydrochemical Techniques, Inc.; HydroClean HT-300 Solvent Paint Remover.
 - c. PROSOCO, Inc.; Sure Klean Fast Acting Stripper.
 - d. Shore Corporation; 2210 SB Paint Remover or 2230 Shore Strip.
- D. Low-Odor, Solvent-Type Paste Paint Remover: Manufacturer's standard low-odor, water-rinsable, solvent-type paste, gel, or foamed emulsion formulation for removing paint from masonry, stone, wood, plaster, or metal as required to suit Project; and containing no methanol or methylene chloride.
- E. Products: Subject to compliance with requirements, provide one of the following:
- a. ABR Products, Inc.; ABR Citrus Paint Removers or Super Bio Strip Gel.
 - b. Cathedral Stone Products, Inc.; S-301, S-303 or S-305.
 - c. Dumond Chemicals, Inc.; Peel Away 7 without paper covering Smart Strip or Smart Strip Pro.
 - d. EaCo Chem, Inc.; InStrip.
 - e. PROSOCO, Inc.; Enviro Klean SafStrip or Enviro Klean SafStrip 8.
- F. Covered, Solvent-Type Paste Paint Remover: Manufacturer's standard, low-odor, covered, water-rinsable, solvent-type paste or gel formulation for removing paint from masonry, stone, wood, plaster, or metal as required to suit Project; and containing no methanol or methylene chloride.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dumond Chemicals, Inc.; Peel Away 6 or Peel Away 7.
 - b. PROSOCO, Inc.; Enviro Klean Safety Peel 1.

2.3 PAINT, GENERAL

- A. Material Compatibility:

- B. Provide materials for use within each paint 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.
 - 1. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- C. Colors: To be selected by Architect from manufacturer's full range of colors

2.4 HISTORIC PAINT MATERIALS

- A. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base:]
- B. Flat Paints and Coatings: 50 g/L.
 - 1. Nonflat Paints and Coatings: 150 g/L.
 - 2. Primers, Sealers, and Undercoaters: 200 g/L.
 - 3. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
 - 4. Pretreatment Wash Primers: 420 g/L.
 - 5. Floor Coatings: 100 g/L.
 - 6. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
 - 7. Shellacs, Clear: 730 g/L.
 - 8. Shellacs, Pigmented: 550 g/L.
 - 9. Stains: 250 g/L.
- C. Low-Emitting Materials: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.5 MODERN PAINT MATERIALS, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base:
- C. Flat Paints and Coatings: 50 g/L.
 - 1. Nonflat Paints and Coatings: 150 g/L.
 - 2. Primers, Sealers, and Undercoaters: 200 g/L.
 - 3. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
 - 4. Pretreatment Wash Primers: 420 g/L.
 - 5. Floor Coatings: 100 g/L.
 - 6. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
 - 7. Shellacs, Clear: 730 g/L.
 - 8. Shellacs, Pigmented: 550 g/L.
 - 9. Stains: 250 g/L.
- D. Low-Emitting Materials: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- E. Transition Coat: Paint manufacturer's recommended coating for use where a residual existing coating is incompatible with the paint system.

2.6 MODERN PAINT MATERIAL MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide products indicated in "Modern Paint Materials" Article or comparable product by one of the following:
 - 1. The Sherwin Williams Company. Contact field product representative Patrick Acosta 210-336-7980 swrep4908@sherwin.com for pre-installation conference with Architect, Contractor and Installer.

2.7 MODERN PAINT MATERIALS – PAINT SCHEDULE

EXTERIOR SURFACES:		1 COAT (PRIMER)	2 COATS
Steel Windows, Metal Gates, Steel and Iron Elements	Sherwin Williams	Kem Kromic (B50nz6)	DTM Latex Semi-Gloss (b66w101)
Exterior Plaster	Sherwin Williams	Loxon (LX02 Series)	Emerald Exterior (B43)
C.M.U.	Sherwin Williams	Loxon (LX02 Series)	ConFlex XL
Wood, Opaque Finish Windows, Doors, Frames, Trim, Casings, Fascia, Columns or Mullions, Headers or Beams	Sherwin Williams	Exterior Oil Primer (y24W8020)	Emerald Exterior
INTERIOR SURFACES:			
Wood, Opaque, Alkyd Enamel Finish			ProClassic Oil B34 Series Semigloss B33 Eggshell
Doors and Windows, Frames, Trim, Casings	Sherwin Williams	B79 Series ProBlock Oil	
Interior Plaster	Sherwin Williams	Loxon (LX02 Series)	Emerald Interior

2.8 PATCHING MATERIALS

- A. Wood-Patching Compound: Two-part, epoxy-resin, wood-patching compound; knife-grade formulation as recommended in writing by manufacturer for type of wood repair indicated, tooling time required for the detail of work, and site conditions. Compound shall be designed for filling voids in damaged wood materials that have deteriorated due to weathering and decay. Compound shall be capable of filling deep holes and spreading to feather edge.
 - 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. Abatron, Inc.; LiquidWood with WoodEpoxy.
 - b. Advanced Repair Technology, Inc.; Primatrate with Flex-Tec HV.
 - c. ConServ Epoxy LLC; Flexible Epoxy Consolidant 100 with Flexible Epoxy Patch 200.
 - d. Gougeon Brothers, Inc.; West System (thickened with filler).
 - e. Polymeric Systems, Inc.; QuickWood.
 - f. Protective Coating Company; PC-Woody.
 - g. System Three Resins, Inc.; Sculpwood.
- B. Gypsum-Plaster Patching Compound: Finish coat plaster and bonding compound according to ASTM C 842 and manufacturer's written instructions.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent chemical solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.
- B. Cover adjacent surfaces with materials that are proven to resist chemical solutions being used unless the solutions will not damage adjacent surfaces. Use protective materials that are UV resistant and waterproof. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
 - 1. Do not apply chemical solutions during winds of sufficient force to spread them to unprotected surfaces.
 - 2. Neutralize and collect alkaline and acid wastes before disposal.
 - 3. Dispose of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

3.2 HISTORIC TREATMENT OF PAINTING, GENERAL

- A. Historic Treatment Appearance Standard: Completed work is to have a uniform appearance as viewed by Architect from building interior at 5 feet (1.5 m) away from painted surface and from building exterior at 20 feet (6 m) away from painted surface.
- B. Execution of the Work: In treating historic items, disturb them as minimally as possible and as follows:
- C. Remove failed coatings and corrosion and repaint.
 - 1. Verify that substrate surface conditions are suitable for painting.
 - 2. Allow other trades to repair items in place and retain as much original material as possible before repainting.
 - 3. Reproduce original, historic paint systems where indicated or scheduled.
 - 4. Install temporary protective measures to protect historic painted surfaces that shall be treated later.

- D. Mechanical Abrasion: Where mechanical abrasion is needed for the work, use only the gentlest mechanical methods, such as scraping and lightly hand sanding, that will not abrade softer substrates, reducing clarity of detail. Do not use abrasive methods such as rotary sanding, rotary wire brushing, or power tools except as indicated as part of the historic treatment program and as approved by Architect.
- E. Heat Processes: Do not use torches, heat guns, or heat plates.

3.3 EXAMINATION

- A. Examine substrates and conditions, with historic treatment specialist present, for compliance with requirements for maximum moisture content and other conditions affecting performance of painting work. Comply with paint manufacturer's written instructions for inspection.
- B. Maximum Moisture Content of Substrates: Do not begin application of coatings unless moisture content of exposed surface is below the maximum value recommended in writing by paint manufacturer and not greater than the following maximum values when measured with an electronic moisture meter appropriate to the substrate material:
 - 1. Gypsum Board: 12 percent.
 - 2. Gypsum Plaster: 12 percent.
 - 3. Wood: 15 percent.
- C. Alkalinity: Do not begin application of coatings unless surface alkalinity is within range recommended in writing by paint manufacturer. Conduct alkali testing with litmus paper on exposed plaster, cementitious, and masonry surfaces.
- D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- E. If existing surfaces cannot be prepared to an acceptable condition for proper finishing by using specified surface-preparation methods, notify Architect in writing.
- F. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
- G. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.4 PREPARATORY CLEANING

- A. Use only the gentlest, appropriate method necessary to clean surfaces in preparation for painting. Clean all surfaces, corners, contours, and interstices.
- B. Detergent Cleaning: Wash surfaces by hand using clean rags, sponges, and bristle brushes. Scrub surface with detergent solution and bristle brush until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet. Rinse with water applied by clean rags or sponges.
- C. Solvent Cleaning: Use solvent cleaning to remove oil, grease, smoke, tar, and asphalt from painted or unpainted surfaces before other preparation work. Wipe surfaces with solvent using clean rags and sponges. If necessary, spot-solvent cleaning may be employed just prior to commencement of paint application, provided enough time is allowed for complete evaporation. Use clean solvent and clean rags for the final wash to ensure that all foreign materials have been removed. Do not use solvents, including primer thinner and turpentine, that leave residue.
- D. Mildew: Clean off existing mildew, algae, moss, plant material, loose paint, grease, dirt, and other debris by scrubbing with bristle brush or sponge and detergent solution. Scrub mildewed areas with mildewcide. Rinse with water applied by clean rags or sponges.
- E. Chemical Rust Removal:
- F. Remove loose rust scale with approved abrasives for ferrous-metal cleaning.
 - 1. Apply rust remover with brushes or as recommended in writing by manufacturer.

2. Allow rust remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing. Do not allow extended dwell time.
 3. Wipe off residue with mineral spirits and either steel wool or soft rags, or clean with method recommended in writing by manufacturer to remove residue.
 4. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
 5. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.
- G. Mechanical Rust Removal:
- H. Remove rust with approved abrasives for ferrous-metal cleaning. Clean to bright metal.
1. Wipe off residue with mineral spirits and either steel wool or soft rags.
 2. Dry immediately with clean, soft cloths. Follow direction of grain in metal.
 3. Prime immediately to prevent rust. Do not touch cleaned metal surface until primed.

3.5 PAINT REMOVAL

- A. General: Remove paint where indicated. Where cleaning methods have been attempted and further removal of the paint is required because of incompatible or unsatisfactory surfaces for repainting, remove paint to extent required by conditions.
- B. Application: Apply paint removers according to paint-remover manufacturer's written instructions. Do not allow paint removers to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.
- C. Apply materials to all surfaces, corners, contours, and interstices, to provide a uniform final appearance without streaks.
1. After work is complete, remove protection no longer required. Remove tape and adhesive marks.
- D. Brushes: Use brushes that are resistant to chemicals being used.
- E. Metal Substrates: If using wire brushes on metal, use brushes of same metal composition as metal being treated.
1. Wood Substrates: Do not use wire brushes.
- F. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that spray methods do not damage surfaces.
- G. Equip units with pressure gages.
1. Unless otherwise indicated, hold spray nozzle at least 6 inches (150 mm) from surface and apply material in horizontal, back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.
 2. For chemical spray application, use low-pressure tank or chemical pump suitable for chemical indicated, equipped with nozzle having a cone-shaped spray.
 3. For water-spray application, use fan-shaped spray tip that disperses water at an angle of 25 to 50 degrees.
 - a. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F (60 and 71 deg C) at flow rates indicated.
- H. Paint Removal with Hand Tools: Remove paint manually using hand-held scrapers, wire brushes, sandpaper, and metallic wool as appropriate for the substrate material. Do not use other methods except as indicated as part of the historic treatment program and as approved by Architect.
- I. Paint Removal with Alkaline Paste Paint Remover:
1. Remove loose and peeling paint using water, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
 2. Apply paint remover to dry, painted surface with brushes.

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3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
 4. Rinse with cold water applied by low pressure spray to remove chemicals and paint residue.
 5. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
 6. Repeat process if necessary to remove all paint.
- J. Paint Removal with Covered or Skin-Forming Alkaline Paint Remover:
1. Remove loose and peeling paint using water, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
 2. Apply paint remover to dry, painted surface with brushes or as recommended in writing by manufacturer.
 3. Apply cover according to manufacturer's written instructions.
 4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
 5. Scrape off paint and remover.
 6. Rinse with cold water applied by low pressure spray to remove chemicals and paint residue.
 7. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
 8. For spots of remaining paint, apply alkaline paste paint remover according to "Paint Removal with Alkaline Paste Paint Remover" Paragraph.
- K. Paint Removal with Solvent-Type Paste Paint Remover:
1. Remove loose and peeling paint using water, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
 2. Apply thick coating of paint remover to dry, painted surface with natural-fiber cleaning brush, deep-nap roller, or large paintbrush. Apply in one or two coats according to manufacturer's written instructions.
 3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
 4. Rinse with cold water applied by low-pressure spray to remove chemicals and paint residue.
 5. Use mechanical methods recommended in writing by manufacturer to remove chemicals and paint residue.
 6. Repeat process if necessary to remove all paint.
- L. Paint Removal with Covered, Solvent-Type Paste Paint Remover:
1. Remove loose and peeling paint using water, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
 2. Apply paint remover to dry, painted surface with natural-fiber cleaning brush, deep-nap roller, or large paint brush or as recommended in writing by manufacturer.
 3. Apply cover according to manufacturer's written instructions.
 4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
 5. Scrape off paint and remover.
 6. Rinse with cold water applied by low-pressure spray to remove chemicals and paint residue.
 7. Use mechanical methods recommended in writing by manufacturer to remove remaining chemicals and paint residue.
- 3.6 SUBSTRATE REPAIR
- A. General: Repair substrate surface defects that are inconsistent with the surface appearance of adjacent materials and finishes.
 - B. Wood Substrate:

1. Repair wood defects including dents and gouges more than 1/8 inch (3 mm) in size and all holes and cracks by filling with wood-patching compound and sanding smooth. Reset or remove protruding fasteners.
 2. Where existing paint is allowed to remain, sand irregular buildup of paint, runs, and sags to achieve a uniformly smooth surface.
- C. Gypsum-Plaster and Gypsum-Board Substrates:
1. Repair defects including dents and chips more than 1/8 inch (3 mm) in size and all holes and cracks by filling with gypsum-plaster patching compound and sanding smooth. Remove protruding fasteners.
 2. Rout out surface cracks to remove loose, unsound material; fill with patching compound and sand smooth.

3.7 PAINT APPLICATION, GENERAL

- A. Comply with manufacturers' written instructions for application methods unless otherwise indicated in this Section.
- B. Prepare surfaces to be painted according to the Surface-Preparation Schedule and with manufacturer's written instructions for each substrate condition.
- C. Apply a transition coat over incompatible existing coatings.
- D. Blending Plain Painted Surfaces: When painting new substrates patched into existing surfaces or touching up missing or damaged finishes, apply coating system specified for the specific substrate. Apply final finish coat over entire surface from edge to edge and corner to corner.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a testing agency to perform tests and inspections. Allow inspectors use of lift devices and scaffolding, as needed, to perform inspections.
- B. Notify testing agency in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until testing agency has had reasonable opportunity to inspect work areas at lift device or scaffold location.
- C. Manufacturer's Field Service: Engage paint-remover manufacturer's factory-authorized service representative for consultation and Project-site inspection, and provide on-site assistance when requested by Architect.
- D. Paint Material Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for composition and dry film thickness.
- E. Paint Composition: The following procedure may be performed at any time and as often as Owner deems necessary during the period when paints are being applied:
- F. Testing agency will sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
 1. Testing agency will perform tests for compliance of paint materials with product requirements.
 2. If test results show materials being used do not comply with product requirements, Contractor shall remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.
- G. Dry Film Thickness:
- H. Contractor shall touch up and restore painted surfaces damaged by testing.
 1. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written instructions, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written instructions.

3.9 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, 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 painted surfaces.

3.10 SURFACE-PREPARATION SCHEDULE

- A. General: Before painting, prepare surfaces for painting according to applicable requirements specified in this schedule.
- B. Examine surfaces to evaluate each surface condition according to paragraphs below.
- C. Where existing degree of soiling prevents examination, preclean surface and allow it to dry before making an evaluation.
 - 1. Repair substrate defects according to "Substrate Repair" Article.
- D. Surface Preparation for MPI DSD 0 Degree of Surface Degradation:
- E. Surface Condition: Existing paint film in good condition and tightly adhered.
 - 1. Paint Removal: Not required.
 - 2. Preparation for Painting: Wash surface by detergent cleaning; use solvent cleaning where needed. Roughen or degloss cleaned surfaces to ensure paint adhesion according to paint manufacturer's written instructions.
- F. Surface Preparation for MPI DSD 1 Degree of Surface Degradation:
- G. Surface Condition: Paint film cracked or broken but adhered.
 - 1. Paint Removal: Scrape by hand-tool cleaning methods to remove loose paint until only tightly adhered paint remains.
 - 2. Preparation for Painting: Wash surface by detergent cleaning; use other cleaning methods for small areas of bare substrate if required. Roughen, degloss, and sand the cleaned surfaces to ensure paint adhesion and a smooth finish according to paint manufacturer's written instructions.
- H. Surface Preparation for MPI DSD 2 Degree of Surface Degradation:
- I. Surface Condition: Paint film loose, flaking, or peeling.
 - 1. Paint Removal: Remove loose, flaking, or peeling paint film by hand-tool or chemical paint-removal methods.
 - 2. Preparation for Painting: Wash surface by detergent cleaning; use solvent cleaning where needed. Use other cleaning methods for small areas of bare substrate if required. Sand surfaces to smooth remaining paint film edges. Prepare bare cleaned surface to be painted according to paint manufacturer's written instructions for substrate construction materials.
- J. Surface Preparation for MPI DSD 3 Degree of Surface Degradation:
 - 1. Surface Condition: Paint film severely deteriorated obscuring fine architectural detail work because of paint-layer buildup and surface indicated to have paint completely removed.
 - 2. Paint Removal: Completely remove paint film by hand-tool or chemical paint-removal methods. Remove rust.
 - 3. Preparation for Painting: Prepare bare cleaned surface according to paint manufacturer's written instructions for substrate construction materials.
- K. Surface Preparation for MPI DSD 4 Degree of Surface Degradation:

- L. Surface Condition: Missing material, small holes and openings, and deteriorated or corroded substrate.
 - 1. Substrate Preparation: Repair, replace, and treat substrate according to "Substrate Repair" Article[and requirements in other Specification Sections.
 - 2. Preparation for Painting: Sand substrate surfaces to smooth remaining paint film edges and prepare according to paint manufacturer's written instructions for substrate construction materials. Remove rust.
 - 3. Painting: Paint as required for MPI DSD 2 degree of surface degradation.

PART 4 – SCHEDULES

- 4.1 Refer to Article 2.7 of this Section, Modern Paint Materials – Paint Schedule.

END OF SECTION 09 03 91

SECTION 093000 – TILING

PART 1- PRODUCTS

1.1 SUMMARY

A. Section Includes:

1. Tile wall finishes.

B. Related Sections:

1. Division 01: Administrative, procedural, and temporary work requirements.
2. Section 079223 - Interior Joint Sealants.

1.2 SUBMITTALS

A. Submittals for Review:

1. Product Data: Manufacturer's installation, cleaning, and maintenance instructions.
2. Samples:
 - a. Tile: Full size samples in each color.
 - b. Grout: 1/2 x 1/2 x 3 inch long samples in each color.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Minimum 2 years documented experience in work of this Section.

B. Tile and Trim Units: Meet ANSI A137.1, Standard Grade.

C. Dynamic Coefficient of Friction for Floor Tile: Minimum 0.42, tested in accordance with ANSI A137.1 using BOT-3000 tribometer.

D. Mockup:

1. Show each tile type and application.
2. Locate where directed.
3. Approved mockup may remain a part of the Work.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver mortar, adhesive, and grout containers bearing hallmark certifying compliance with reference standards.

B. Protect adhesive containers from freezing and overheating according to manufacturer's instructions.

1.5 PROJECT CONDITIONS

- A. Environmental Requirements: Maintain minimum ambient temperature of 50 degrees F during and after installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Contract documents are based on tile products by D'Hanis Clay Products, Inc.
- B. Acceptable Manufacturers - Setting and Grouting Materials:
 - 1. Sika. (www.sika.com)
 - 2. Bostik, Inc. (www.bostik-us.com)
 - 3. Laticrete International, Inc. (www.laticrete.com)
 - 4. Mapei Corporation. (www.mapei.us)
 - 5. TEC. (www.tecspecialty.com)

- C. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. TL-1 - Tile:
 - 1. Source: Clay Floor Tile by D'Hanis Clay Products, Inc.
 - 2. Performance Requirements:
 - a. Meet or exceed ASTM C902 (Pedestrian & Light Traffic Paving Brick), Class MX, Type II, Application PS, which requires an average minimum compressive strength of 3,000 psi and an average absorption of 14 percent.
 - b. Slip resistant, exceed ASTM C1028 Static Coefficient of Friction, with the highest rating 0.6fc.
 - 3. Size: Nominal 8" x 8" x 1/2".

2.3 ACCESSORIES

- A. Improved Latex-Portland Cement Mortar: ANSI A118.15, polymer modified, high performance, dry set type.
- B. Dry Set Mortar for Large and Heavy Tiles: ANSI A118.1, A118.4, A118.11, or A118.15; thin set mortar formulated by manufacturer to minimize slump and to facilitate thicker bond coat.
- C. Water: Clean, potable.
- D. Grout:
 - 1. Type: ANSI A118.7, high-performance, fine aggregate, fast-setting, polymer-modified, nonshrinking, efflorescence-free, for use in joint widths from 1/16 to 3/4 inch in width.
 - 2. Color: To be selected from manufacturer's full color range.
- E. Joint Sealants: Specified in Section 079223.
- F. Accessories and Transitions: Schluter (www.schluter.com), type suitable for conditions.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean surfaces to remove loose and foreign matter that could impair adhesion.
- B. Remove ridges and projections. Fill voids and depressions with patching compound compatible with setting materials.
- C. Allowable Substrate Tolerances:
 - 1. Thin Set Method:
 - a. Maximum variation in substrate surface: 1/8 inch in 8 feet.
 - b. Maximum height of abrupt irregularities: 1/32 inch.
 - 2. Large format tiles with at least one dimension exceeding 15 inches and heavy tiles exceeding 5 pounds per square foot:
 - a. Maximum variation in substrate surface: 1/8 inch in 10 feet and maximum 1/16 inch in 24 inches.
 - b. Maximum height of abrupt irregularities: 1/32 inch.
- D. Test concrete substrate to ASTM D4263; do not install tile until surfaces are sufficiently dry.

3.2 INSTALLATION

- A. Install crack suppression membrane in accordance with manufacturer's instructions.
- B. Method:
 - 1. Walls and Floors: ANSI A108.5, thin set with latex-Portland cement mortar.
- C. Minimize pieces less than one half size. Locate cuts to be inconspicuous.
- D. Lay tile to pattern furnished by Architect. Do not interrupt tile pattern through openings.
- E. No cut tiles exposed to view will be allowed. Install bullnose trim pieces where necessary to avoid this condition.
- F. Joint Width: Width recommended by manufacturer; 3/8 inch with flush joint; plus or minus 1/16 inch.
- G. Make joints watertight, without voids, cracks, excess mortar, or excess grout. Align joints in wall and floor of same-sized tile.
- H. Fit tile around projections and at perimeter. Smooth and clean cut edges. Ensure that trim will completely cover cut edges.

- I. Install Trim: Refer to Drawings for types and locations.
- J. Allow tile to set for a minimum of 48 hours before grouting.
- K. Grout tile joints in accordance with ANSI A108.10 without excess grout.
- L. Control Joints:
 - 1. Provide control joints at:
 - a. Changes in backup material.
 - b. Changes in plane.
 - c. Over joints in substrate.
 - d. Maximum 24 feet on center at interior locations except maximum 8 feet at surfaces exposed to direct sunlight.
 - 2. Form joints per TCNA Method EJ-171.
 - 3. Install joint backing and joint sealant as specified in Section 079223.

3.3 ADJUSTING

- A. Remove and replace pieces that have been damaged during installation.

END OF SECTION

SECTION 096400 - WOOD FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Prefinished wood strip flooring.
- B. Related Sections:
 - 1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 SUBMITTALS

- A. Submittals for Review:
 - 1. Samples: 24 inch long flooring samples.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Minimum 3 years documented experience in work of this Section.
- B. Coefficient of Friction: Minimum 0.43, tested to ANSI B101.3.
- C. Mockup:
 - 1. Size: 8 x 8 feet.
 - 2. Show: Flooring size, pattern, and finish.
 - 3. Locate where directed.
 - 4. Approved mockup may remain as part of the Work.

1.4 PROJECT CONDITIONS

- A. Do not install flooring until overhead and adjacent work is complete.
- B. Environmental Requirements: Maintain following conditions in areas to receive flooring for minimum 72 hours prior, during, and after installation:
 - 1. Temperature: 65 degrees F minimum.
 - 2. Humidity: 50 percent maximum.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Contract documents are based on products by Delta Millworks. (www.deltamillworks.com)
- B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. WD-1 - Wood Strip Flooring:
 - 1. Source: Prefinished Wood Flooring by Delta Millworks.
 - 2. Species: French White Oak.
 - 3. Nominal sizes: 1 inch x 8 inches.
 - 4. Edge configuration: Tongue and groove, end matched.
 - 5. Finish: Laredo.

2.3 ACCESSORIES

- A. Sheathing: Refer to Structural.
- B. Fasteners: Type and length recommended by flooring manufacturer, hot dip galvanized steel.
- C. Underlayment: Red Rosin Paper, 15-pound felt paper, or type recommended by flooring manufacturer.
- D. Leveling Compound: Premixed, white, latex based.
- E. Adhesive: Type recommended by flooring manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

- A. At least 72 hours prior to beginning installation, stack flooring in areas to receive flooring to allow to reach prevailing temperature and humidity.
- B. Clean substrate; remove loose and foreign matter that could impede performance of flooring.
- C. Test concrete substrate for moisture content to ASTM F1869. Test gypsum concrete underlayment to ASTM F2659 using Protimeter moisture meter. Do not install flooring until moisture emission level is acceptable to flooring manufacturer.

3.2 INSTALLATION OF FLOORING – MECHANICALLY FASTENED

- A. Install in accordance with manufacturer's instructions and NOFMA "Hardwood Flooring Installation Manual".
- B. Install underlayment according to manufacturer's recommendations.
- C. Place flooring perpendicular to sleepers and square with room.
- D. Offset end joints in adjacent rows 12 inches minimum. Butt ends and edges to moderate contact.

- E. Cut flooring to fit at perimeter and around penetrations with maximum 3/4 inch gaps.
- F. Do not install pieces less than 12 inches in length.
- G. Blind nail through tongue edge at maximum 12 inches on center and within 6 inches of ends. Face nail last piece in each row, with nails located under wall base or perimeter trim.

3.3 INSTALLATION OF FLOORING - ADHESIVE APPLIED

- A. Install in accordance with manufacturer's instructions.
- B. Apply adhesive to subfloor using notched trowel; follow manufacturer's instructions for application and coverage. Do not cover more area than can be covered with flooring before adhesive sets.
- C. Set each piece firmly into adhesive, using slight sliding motion to ensure full contact.
- D. Place flooring square with room.
- E. Offset end joints in adjacent rows 12 inches minimum. Butt ends and edges to moderate contact.
- F. Cut flooring to fit at perimeter and around penetrations with maximum 3/4 inch gaps.
- G. Roll completed flooring prior to final adhesive set with 100 pound roller.

END OF SECTION

SECTION 099123 – INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Surface preparation and field application of paints.

B. Related Sections:

1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 SUBMITTALS

A. Submittals for Review:

1. Product Data: Manufacturer's data on materials proposed for use including:
 - a. Product designation and grade.
 - b. Product analysis and performance characteristics.
 - c. Standards compliance.
 - d. Material content.
 - e. Mixing and application procedures.
2. Samples: 3 x 6 inch samples of each coating system on representative substrate. Step back successive coats so that all coats remain exposed. Indicate type of material used for each coat.
3. Paint Schedule: Indicate types and locations of each surface, paint materials, and number of coats to be applied.

1.3 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum 2 years documented experience in work of this Section.

B. Materials, Preparation, and Workmanship: Conform to MPI Painting Manual.

1.4 DELIVERY, STORAGE AND HANDLING

A. Container Labels: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage rates, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

B. Paint Materials: Store at ambient temperature from 45 to 90 degrees F in ventilated area, or as required by manufacturer's instructions.

1.5 PROJECT CONDITIONS

- A. Do not apply materials when surface and ambient temperatures or relative humidity are outside ranges required by paint manufacturer.
- B. Maintain ambient and substrate temperatures above manufacturer's minimum requirements for 24 hours before, during, and after paint application.
- C. Do not apply materials when relative humidity is above 85 percent or when dew point is less than 5 degrees F different than ambient or surface temperature.
- D. Provide lighting level of 30 footcandles at substrate surface.

1.6 MAINTENANCE

- A. Extra Materials: 1 gallon of each color and sheen.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Contract documents are based on products by Sherwin Williams. (www.sherwin-williams.com)
- B. Other Acceptable Manufacturers:
 - 1. Benjamin Moore and Co. (www.benjaminmoore.com)
 - 2. PPG Paints. (www.ppgpaints.com)
- C. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. Paints:
 - 1. As scheduled at end of Section, or approved substitute.
 - 2. Free from all forms of lead and mercury.
- B. Paint Colors:
 - 1. PT-1 - Wall Paint at Pump House and Pavilion A&B: Sherwin-Williams Creamy white.
 - 2. PT-2 - Interior Existing Rafters And All Interior Existing Architectural Wood Elements at Pump House, Pavilion A&B: Sherwin-Williams Dark brown paint.
 - 3. PT-3 - Ceiling Paint at Pump House: Sherwin-Williams Light creamy beige.
- C. Maximum Volatile Organic Compound (VOC) Content for interior paints, coatings, and accessories, tested to ASTM D6886:
 - 1. Primers: 100 grams per liter.
 - 2. Flat paints and coatings: 50 grams per liter.
 - 3. Non-flat paints and coatings: 50 grams per liter.
 - 4. Rust preventative coatings: 100 grams per liter.

5. Dryfall coatings: 150 grams per liter.

D. Gloss Ratings:

Gloss Designation	Units at 60 Degrees	Units at 85 Degrees
Flat	0 to 5	Maximum 10
Eggshell	10 to 25	10 to 35
Satin	20 to 35	Minimum 35
Semigloss	35 to 70	
Gloss	70 to 85	
High Gloss	Minimum 85	

2.3 ACCESSORIES

- A. Accessory Materials: Paint thinners and other materials required to achieve specified finishes; commercial quality.
- B. Patching Materials: Latex filler.
- C. Fastener Head Cover Materials: Latex filler.

2.4 MIXES

- A. Deliver paints pre-mixed and pre-tinted.
- B. Uniformly mix to thoroughly disperse pigments.
- C. Do not thin in excess of manufacturer's recommendations.
- D. Re-mix paint during application; ensure complete dispersion of settled pigment and uniformity of color and gloss.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Test shop applied primer for compatibility with subsequent coatings.
- B. Measure moisture content of surfaces using electronic moisture meter. Do not apply coatings unless moisture content of surfaces are below following maximums:
 - 1. Gypsum board: 12 percent.
 - 2. Masonry and Concrete: 12 percent.

3.2 PREPARATION

A. General:

1. Protect adjacent and underlying surfaces.
2. Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.
3. Correct defects and clean surfaces capable of affecting work of this section.
4. Seal marks that may bleed through surface finishes with waterborne stain blocker.

B. Impervious Surfaces: Remove mildew by scrubbing with solution of trisodium phosphate and bleach. Rinse with clean water and allow to dry.

C. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.

D. Concrete and Masonry:

1. Remove dirt, loose mortar, scale, salt and alkali powder, and other foreign matter.
2. Remove oil and grease with solution of trisodium phosphate; rinse and allow to dry.
3. Remove stains caused by weathering of corroding metals with solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.

E. Galvanized Steel: SSPC Method SP1 - Solvent Cleaning.

F. Aluminum: SSPC Method SP1 - Solvent Cleaning.

G. Uncoated Ferrous Metals: SSPC Method SP2 - Hand Tool Cleaning or Method SP3 - Power Tool Cleaning.

H. Shop Primed Ferrous Metals:

1. SSPC Method SP2 - Hand Tool Cleaning or Method SP3 - Power Tool Cleaning.
2. Feather edges to make patches inconspicuous.
3. Prime bare steel surfaces.

I. Existing Surfaces:

1. Remove loose, flaking, powdery, and peeling paints.
2. Lightly sand glossy painted surfaces.
3. Fill holes, cracks, depressions and other imperfections with patching compound; sand flush with surface.
4. Remove oil, grease, and wax by scraping; solvent wash and thoroughly rinse.
5. Remove rust by wire brushing to expose base metal.

3.3 APPLICATION

A. Apply paints in accordance with manufacturer's instructions and MPI Painting Manual, Custom Grade finish requirements.

B. Apply primer or first coat closely following surface preparation to prevent recontamination.

- C. Do not apply finishes to surfaces that are not dry.
 - D. Apply coatings to minimum dry film thickness recommended by manufacturer.
 - E. Apply each coat of paint slightly darker than preceding coat unless specified otherwise.
 - F. Apply coatings to uniform appearance without laps, sags, curtains, holidays, and brush marks.
 - G. Allow applied coats to dry before next coat is applied.
 - H. When required on deep and bright colors apply an additional finish coat to ensure color consistency.
 - I. Continue paint finishes behind wall-mounted accessories.
 - J. Sand between coats on interior metal surfaces.
 - K. Match final coat to approved color samples.
 - L. Mechanical and Electrical Components:
 - 1. Paint factory primed equipment.
 - 2. Remove unfinished and primed louvers, grilles, covers, and access panels; paint separately.
 - 3. Paint exposed and insulated pipes, conduit, boxes, ducts, hangers, brackets, collars, and supports unless factory finished.
 - 4. Do not paint name tags or identifying markings.
 - 5. Paint exposed conduit and electrical equipment in finished areas.
 - 6. Paint duct work behind louvers, grilles, and diffusers flat black to minimum of 18 inches or beyond sight line.
 - M. Do not Paint:
 - 1. Surfaces indicated on Drawings or specified to be unpainted or unfinished.
 - 2. Surfaces with factory applied finish coat or integral finish.
 - 3. Architectural metals, including brass, bronze, stainless steel, and chrome plating.
- 3.4 ADJUSTING
- A. Touch up or refinish disfigured surfaces.
- 3.5 CLEANING
- A. Remove paint from adjacent surfaces.
- 3.6 PAINT SCHEDULE
- A. Types of paint listed herein are set forth as standard of quality and type of coating required for each type of surface.

1. Paint exposed surfaces of types listed in Paint Schedule.
 2. Paint other exposed surfaces not specifically listed with not less than two coats of appropriate type of coating.
- B. Prime coat consists of touch up on shop primed surfaces with intact coatings.

SUBSTRATE	MANUFACTURER	PRIMER	TOP COATS
Interior Surfaces:			
Overhead Structure	Sherwin Williams	One coat Pro Industrial Pro-Cryl Prime (if recommended by manufacturer based on conditions)	Two coats Pro Industrial Waterborne Dryfall
Gypsum Board - Ceilings, Latex Satin Finish	Sherwin Williams	One coat ProMar 200 Zero VOC Interior Latex Primer	Two coats ProMar 200 Zero VOC Interior Latex Satin Wall Paint
Gypsum Board - Walls, Latex Eggshell/Satin Enamel Finish	Sherwin Williams	One coat ProMar 200 Zero VOC Interior Latex Primer	Two coats ProMar 200 Zero VOC Interior Latex Eg-Shel Enamel
Gypsum Board, Latex Semi-Gloss Finish	Sherwin Williams	One coat ProMar 200 Zero VOC Interior Latex Primer	Two coats ProMar 200 Zero VOC Interior Latex Semi-Gloss Enamel
Ferrous and Galvanized Metals - Semi-Gloss	Sherwin Williams	One coat Pro-Cryl Universal Water Based Primer	Two coats Pro Industrial Acrylic Semi-Gloss
Wood, Opaque, Latex Semi-Gloss Enamel	Sherwin Williams	One coat Premium Wall & Wood Interior Latex Primer	Two coats ProMar 200 Zero VOC Interior Latex Semi-Gloss

END OF SECTION

SECTION 099600 - HIGH PERFORMANCE COATINGS

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. Coatings for Steel Railings & Guardrails.

B. Related Requirements:

- 1. Section 055213 "Pipe and Tube Railings."
- 2. Section 323400 "Fabricated Bridges".

1.3 WORK INCLUDED:

- A. Products provided and supplied under this Section are special coating materials requiring applicable expertise in surface preparation, application, and safety procedures.
- B. Materials, tools, equipment, and scaffolding required for surface preparation and application of special coatings in locations scheduled.

1.4 REFERENCES:

- A. Applicable Standards: Conform to the following Standards:

ASTM B 117: Method of Salt Spray (Fog) Testing

ASTM D 522: Test Method for Elongation of Attached Organic Coatings with Conical Mandrel Apparatus

ASTM D 1653: Method B, Wet Cup, Moisture Vapor Transmission

ASTM D 2246: Method of Testing Finishes of Primed Metallic Substrates for Humidity- Thermal Cycle Cracking

ASTM D 4060: Practice for Testing Abrasion Resistance of Coatings by Taber Abrasion ASTM D

3273: Fungal Resistance

ASTM D 3359: Method for Measuring Adhesion by Tape Test

ASTM D 4141: Method C (EMMAQUA) Solar Concentrating Exposures of Coatings ASTM D 4541:
Method for Pull-off Strength of Coatings Using Portable Adhesion-Testers ASTM D 4585: Practice
for Testing the Water Resistance of Coatings Using Controlled
Condensation

ASTM D 4587: Fluorescent UV-Condensation Exposures of Paint and Coatings ASTM D 6386:
Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated
Iron and Steel Product and Hardware Surfaces for Painting

ASTM G 53: QUV Exposure

Fed. Std. No. 141 Method 6192: Test Method for Abrasion Resistance of
Coatings by the Taber Abraser

FS TT-C-550c: Coating System Glaze, High Performance for Interior Surfaces NFPA

101: Life Safety Code

SSPC - SP1: Solvent Cleaning SSPC

- SP2: Hand Tool Cleaning

SSPC - SP3: Power Tool Cleaning

SSPC - SP6: Commercial Blast Cleaning

SSPC - SP7: Brush-off Blast Cleaning

SSPC - SP10: Near white Metal Blast Cleaning SSPC - SP11: Power Tool

Cleaning to Bare Metal SSPC - SP13: Surface Preparation.

1.5 SUBMITTALS:

B. Product Data:

1. Submit manufacturer's descriptive literature fully describing each product and solids by volume contents.
2. Include manufacturer's recommendations for mixing, thinning, application and curing.
3. Submit manufacturer's product data sheets.
4. Submit special coating schedule indicating locations and applications by manufacturer's name and product number.

C. Samples:

-
1. Submit manufacturer's standard colors for selection by Architect.
 2. Submit two (2) 12" x 12" samples of each coating system in selected colors on substrate sample to be finished.
 3. Indicate finish texture and color.
- D. Test Samples:
1. When requested by Architect, obtain test samples from material stored at project site of source of supply.
 2. Retain all paint cans and lids on site until authorized to discard by Architect.
- E. Certificates: Manufacturer's certified test report from acceptable independent testing laboratory indicating coatings comply with performance requirements.
- 1.6 QUALITY ASSURANCE:
- A. Applicator Qualifications:
1. Applicator shall have minimum five years experience applying special coating materials.
 2. Applicator shall be suggested or pre-approved by manufacturer for this application.
 3. Applicator shall employ skilled mechanics to ensure highest quality workmanship. Materials to be applied by craftsman experienced in use of specified products.
 4. Submit documentation of following minimum applicator qualifications:
 - a. Minimum five years commercial experience applying specified manufacturer's industrial grade coatings.
 - b. Minimum five successful projects of similar scope and complexity.
 - c. List of references for completed projects.
- B. Pre-application Conference: Prior to making field samples and placing order for materials, the installer shall schedule a meeting with the Architect, Owner, General Contractor and manufacturer's representative to agree on methods and schedule for application.
- C. Regulatory Requirements: Comply with applicable codes, regulations, ordinances, and laws regarding use and application of coating systems that contain volatile organic compounds (VOC).
- D. Field Quality Control:
1. Installer shall request acceptance by Owner's Representative of each coat before applying succeeding coats.
 2. Furnish and maintain at Project site following fully calibrated testing and inspection devices:
 - a. Wet Mil Gauge
 - b. Dry Film Gauge with Calibration Shims.
 - c. Holiday Detector.

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- d. Tooke Destructive Mil Gauge.
 - e. Sling Psychrometer.
3. Initiate and maintain for duration of Project field quality control program using certified calibration and testing devices and to ensure conformance with application requirements.
4. Thickness of coatings and paint shall be measured checked according to the procedures outlined in SSPC-PA 2 "Measurement of Dry Film Thickness with Magnetic Gages" with particular attention to section(s) 4.0, 7.8, 7.9, 7.11, 7.13, 7.14, with a non-destructive, magnetic-type thickness gauge that has been calibrated according to the procedures outlined in SSPC-PA 2 "Measurement of Dry Film Thickness with Magnetic Gages" with particular attention to section(s) 3.0, 7.4, 7.5, 7.15. Pass/fail criteria shall require that ninety (90) percent of the spot measurements (average of 3 gauge readings within a 1.5 inch diameter area) be at or above the minimum specified dry film thickness. Of the remaining ten (10) percent of the spot measurements (average of 3 gauge readings within a 1.5 inch diameter area) that are below the minimum specified dry film thickness, they shall be no less than ninety (90) percent of the minimum specified dry film thickness. Areas that fail to meet these criteria shall be corrected at no expense to the Owner. Use of an instrument such as a Tooke Gauge, precision groove grinder, etc. is permitted if a destructive test is deemed necessary by the Engineer and the total DFT is less than 50 mils.
- E. Tests: Where there is any question of dryness of surfaces, test surfaces, test in the presence of the Architect with a reliable electronic moisture meter.
- 1.7 MOCK-UP:
- F. Apply each coating on minimum 4 square feet of area for each type of coating material.
 - G. Mock-up will be used to judge quality and finish of completed work.
 - H. Leave approved mock-up in place as part of completed work if mock-up can be incorporated into work in acceptable manner.
- 1.8 DELIVERY, STORAGE, AND HANDLING:
- I. Deliver materials to Project site in original, factory sealed, unopened, new containers bearing manufacturer's name and label intact and legible, with the following information:
 - 1. Name or title of material.
 - 2. Federal Specification number, if applicable.
 - 3. Manufacturer's stock number and date of manufacturer.
 - 4. Contents by volume for major pigment and vehicle constituents.
 - 5. Thinning instructions.
 - 6. Application instructions.
 - 7. Color name and number.
 - J. Store materials in protected and well ventilated area at temperatures between 40° and 90° degrees F., unless otherwise required by manufacturer.

1.9 ENVIRONMENTAL REQUIREMENTS:

- A. Apply coating materials only under following prevailing conditions, unless otherwise noted on manufacturer's product data:
 - 1. Air and surface temperatures shall not exceed minimum or maximum requirements for product to be applied.
 - 2. Do not apply coatings to damp or wet surfaces.
 - 3. Relative humidity is not above 85% and surface temperature is at least 5 degrees F above dew point.
 - 4. Wind velocity must be below 20 mph for exterior applications.

PART 2 - MATERIALS

2.01 MANUFACTURERS:

- A. Materials specified are those that have been evaluated for the specific service. Products of the Tnemec Company, Inc. are listed to establish a standard of quality. Equivalent materials of other manufacturer's may be submitted on written approval of the Architect. As part of the proof of equality, the Architect will require at the cost of the Contractor, certified test reports from a nationally known, reputable and independent testing laboratory conducting comparative tests as directed by the Engineer between the product specified and the requested substitution.
- B. Requests for substitution shall include manufacturer's literature for each product giving name, product number, generic type, descriptive information, solids by volume, recommended dry film thickness and certified lab test reports showing results to equal the performance criteria of the products specified herein. In addition, a list of five projects shall be submitted in which each product has been used and rendered satisfactory service.
- C. All requests for product substitution shall be made at least 14 days prior to the bid date.
- D. Any material savings shall be passed to the owner in the form of a contract dollar reduction.
- E. Manufacturer's color charts shall be submitted to the Engineer at least 30 days prior to coating and/or paint application. The General Contractor and Painting Contractor shall coordinate work so as to allow sufficient time (normally seven to ten days) for coatings to be delivered to the job site.

2.02 SHOP-PRIMER

- A. Surface Preparation: Prepare all welds as per NACE SP0178, Designation D. Abrasive blast all surfaces as per SSPC-SP6 Commercial Blast Cleaning. A minimum angular profile of 2.0 to 3.0 mils as per ASTM D 4417, Method C or NACE Standard RP0287 is required.
- B. Primer: Tnemec Series 90G-1K97 applied at 2.5 to 3.5 dry mils. Thin only with approved thinner, Tnemec 41-2 or 41-3 Thinner.

2.03 EXTERIOR SYSTEMS SCHEDULE:

A. Exterior Exposed Structural Steel Surface Preparation Prior to Abrasive Blast Cleaning: Weld flux and spatter shall be removed by power tool cleaning. Sharp projections shall be ground to a smooth contour. All welds shall be ground to a smooth contour as per NACE Standard SP0178, Designation

B. Surface Preparation: All surfaces must be clean, dry, and free of contaminants. Clean all bare metal, welded areas, and damaged shop primer as per SSPC-SP6 Commercial Blast Cleaning or SSPC-SP11 Power Tool Cleaning to Bare Metal. Feather all edges smooth. An angular anchor profile of 2.0 mils as per ASTM D 4417, Method C or NACE Standard RP0287 is required.

C. Coating System:

Spot Primer: Tnemec Series 90G-1K97 Tneme-Zinc touch up damaged areas at 2.5 to 3.5 dry mils. Thin only with approved thinner, Tnemec 41-2 or 41-3 Thinner.

2nd Coat: Tnemec Series 66 applied at 2.0 to 3.0 dry mils. Thin only with approved thinner, Tnemec 41-39 or 41-42 Thinner.

3rd Coat: Tnemec Series 1095 Endura-Shield applied at 2.0 to 3.0 dry mils. Thin only with approved thinner, Tnemec 41-10 Thinner.

4th Coat: Tnemec Series 1071 Fluoronar applied at 2.0 to 3.0 dry mils. Thin only with approved thinner, Tnemec 41-63 Thinner. Top coat color to be approved by SWA Architects prior to purchase.

Total dry film thickness shall be a minimum of 8.5 mils.

D. Exterior Exposed Structural Galvanized Steel Surface Preparation Prior to Abrasive Blast Cleaning: Weld flux and spatter shall be removed by power tool cleaning. Sharp projections shall be ground to a smooth contour. All welds shall be ground to a smooth contour as per NACE Standard SP0178, Designation

E. Surface Preparation: All surfaces must be clean, dry, and free of contaminants. Abrasive blast per SSPC-SP16 Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals achieving an angular anchor profile of 2.0 mils as per ASTM D 4417, Method C or NACE Standard RP0287 is required.

F. Coating System:

1st Coat: Tnemec Series 66 applied at 4.0 to 6.0 dry mils. Thin only with approved thinner, Tnemec 41-39 or 41-42 Thinner.

2nd Coat: Tnemec Series 1095 Endura-Shield applied at 2.0 to 3.0 dry mils. Thin only with approved thinner, Tnemec 41-10 Thinner.

3rd Coat: Tnemec Series 1071 Fluoronar applied at 2.0 to 3.0 dry mils. Thin only with approved thinner, Tnemec 41-63 Thinner. Top coat color to be approved by SWA Architects prior to purchase.

Total dry film thickness shall be a minimum of 8.0 mils.

2.04 MIXING & THINNING:

- A. Mix and thin materials in strict accordance with manufacturer's latest printed instructions.
- B. Do not use material beyond manufacturer's recommended pot life.
- C. Project site tinting will not be allowed.
- D. Do not split kits of multi-component products.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Verify surfaces to be coated are dry, clean and ready to accept base coat in accordance with manufacturer's recommendations.
- B. Notify Owner's Representative in writing of unacceptable conditions prior to commencing application.
- C. Do not begin work until unsatisfactory conditions have been corrected.

3.02 GENERAL PREPARATION:

- A. General: Perform preparation and cleaning procedures in strict accordance with coating manufacturer's instructions and as herein specified, for each particular substrate condition.
- B. Protect surrounding and adjacent surface in the manner recommended by coating manufacturer.
- C. Scrape or grind protrusions flush with surface.
- D. Dislodge dirt, mortar and other dry materials by scraping or brushing. Remove dust and loose material by brushing, sweeping, vacuuming and blowing with high-pressure air.
- E. Remove oil, wax and grease by scraping off heavy deposits and cleaning with solvent in accordance with SSPC-SP1.
- F. Remove sealers and any contaminant that may interfere with penetration of sealer and hardener.

3.03 APPLICATION:

- A. Apply in strict accordance with manufacturer's latest printed and published instructions for each product specified.
- B. Do not apply initial coating until moisture content of surface is within limitations recommended by paint manufacturer. Test with moisture meter, if applicable.
- C. Apply additional coats when undercoats, stains or other conditions show through final coat, until coating film is of uniform finish, color and appearance.
- D. Recoat primed and sealed surfaces where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn-through or other defects due to insufficient sealing.
- E. Comply with recommendations of product manufactured for drying time between succeeding coats.
- F. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags or other surface imperfections will not be acceptable.
- G. Make edges of coatings adjoining other materials clean and sharp with no overlapping. Work material into surface voids and hairline cracks.
- H. Provide "Wet Paint" signs as required to protect newly-coated finishes. Remove temporary protective wrappings provided by other for protection of their work, after completion of painting operations.

3.04 CLEANING:

- A. Clean, prepare and touch-up coating system where damaged as per manufacturer's instructions.
- B. Remove spilled, splashed or splattered finish material from all surfaces.
- C. Do not mar surface finish or item being cleaned.
- D. Leave storage space clean and in condition required for equivalent spaces in project.
- E. During progress of work, remove from project daily all discarded materials, rubbish, cans and rags.

3.05 REPAINTING:

- A. Refinish all work which has become damaged or defaced during the course of construction and leave all finishing in clean, neat and perfect condition, acceptable to the Owner's Representative. Replace all broken glass and damaged material directly attributable to work under this Section.

3.06 ACCEPTANCE:

Final acceptance of coatings shall be based upon inspection by the Owner's Representative. Coatings falling below specified and/or scheduled finish and shade shall be redone as required without expense to the Owner.

END OF SECTION 099600

SECTION 101400 - EXTERIOR SIGNAGE

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Exterior Signage Graphics and Elements.
- B. Related Sections:
 - 1. Division 01, GENERAL REQUIREMENTS.
 - 2. Section 033000, CAST-IN-PLACE CONCRETE.
 - 3. Section 099600, HIGH PERFORMANCE COATINGS.
 - 4. Section 129300, SITE FURNISHINGS.
 - 5. Section 324000, FABRICATED BRIDGES.

1.2 SUBMITTALS

- A. Shop Drawings: Indicate sign design, lettering font, foreground and background colors, materials, mounting, assembly, fasteners, adjacencies and overall dimensions of each sign element.
- B. Samples: Submit signage, in sizes as specified, illustrating type, style, letter font, and colors specified, including method of attachment.
- C. Manufacturer's Installation Instructions: Submit installation template and attachment devices data.

1.3 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with five years minimum documented experience.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver signage to the project site, protective wrapped to prevent damage during delivery and storage.
- B. Store signage in dry area protected from the elements.

PART 2 PRODUCTS

2.1 SIGNAGE REQUIREMENTS

- A. Interpretative Signage:
 - 1. Refer to the drawings for materials and design intent.

2.2 ACCESSORIES

- A. Mounting Hardware: Manufacturer's standard holes and tamper-proof screws, washers, and toggles for securing signage to substrates.

PART 3 INSTALLATION

3.1 INSTALLATION

- A. Install signage and elements in locations as indicated on the drawings.
- B. Coordinate installation of signage with bridge railing fabrication.
- C. Mount signage and elements level and plumb to substrates at locations.
- D. Secure signs to substrate with fasteners in accordance with manufacturer's instructions.
- E. Seal connections to create a water tight connection to substrates.

END OF SECTION

SECTION 101423 - INTERIOR PANEL SIGNS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plastic interior panel signs.
- B. Related Sections:
 - 1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 SUBMITTALS

- A. Submittals for Review:
 - 1. Shop Drawings: Include sign locations, sizes, mounting heights, and content.
 - 2. Samples:
 - a. 3 x 3 inch sign samples showing available colors.
 - b. After color selection, submit typical sign illustrating pictograms, characters, and Braille indications.

1.3 QUALITY ASSURANCE

- A. Conform to applicable accessibility code for sign design, construction, location, and mounting height.
- B. Provide signage as required by authority having jurisdiction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. APCO Graphics, Inc. (www.apcosigns.com)
 - 2. Best Sign Systems, Inc. (www.bestsigns.com)
 - 3. Seton Identification Products. (www.seton.com)
- B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. Plastic Interior Signs:

1. Type: Ultraviolet hardened, 1/32 inch thick raised photopolymer characters and Braille, chemically fused to the PETG surface, single piece construction.
2. Thickness: 1/8 inch.
3. Color: To be selected from manufacturer's full color range.
4. Design: As selected by Architect from manufacturer' full range of options.

2.3 ACCESSORIES

- A. Adhesive: Type recommended by sign manufacturer.

2.4 FABRICATION

- A. Fabricate signs by photopolymer process using film negatives to produce characters and graphics in contrasting color, raised 1/32 inch.
- B. Characters:
 1. Height: 5/8 inch.
 2. Style: Sans serif style to be selected, upper case.
 3. Stroke width, strike thickness, character spacing, and line spacing: In accordance with applicable accessibility code.
- C. Pictograms:
 1. Utilize standard international pictograms.
 2. Locate pictograms within 6 inch vertical void with text descriptors below pictogram.
- D. Provide round Grade II Braille indications with contractions placed below each corresponding character.
- E. Corners: Square.
- F. Edges: Square.
- G. Border: 3/8 inch wide.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean surfaces of loose and foreign matter.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved Shop Drawings.

- B. Locate signs on wall adjacent to scheduled doors.

END OF SECTION

SECTION 102113 – METAL TOILET COMPARTMENT DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal toilet partitions.
2. Metal urinal screens.

B. Related Sections:

1. Division 01: Administrative, procedural, and temporary work requirements.
2. Section 102813 - Toilet Accessories.

1.2 SUBMITTALS

A. Submittals for Review:

1. Shop Drawings: Include layout, dimensions, materials, panel construction, finishes, hardware, and accessories.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

1. Bradley Corporation. (www.bradleycorp.com)
2. General Partitions Mfg. Corp. (www.generalpartitions.com.)
3. ASI Global Partitions. (www.globalpartitions.com.)
4. American Standard. (www.americanstandard-us.com)

B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

A. MTL-1 - Stainless Steel: ASTM A666, Type 304 or 316, rollable temper.

B. Core: Water-repellant Kraft paper honeycomb.

C. Hardware: Plated steel, stainless steel, or aluminum.

1. Hinges: Gravity rising or non rising spring tension actuated; conceal operable parts in door.
2. Latches: Sliding type requiring maximum 5 pound force to operate, with emergency release operation.
3. Coat hook and door stop: Combination type with rubber tip.

4. Door strike and keeper with rubber bumper.

2.3 ACCESSORIES

- A. Fasteners: Stainless steel, theft resistant where exposed.

2.4 FABRICATION

- A. Configurations:

1. Description: Toilet Compartment Doors in masonry walls, refer to Drawings.
2. Height: 6'-7 1/2".

- B. Panel Construction:

1. Stainless Steel sheet bonded with waterproof adhesive under heat and pressure to honeycomb core.
2. Edges bound with stainless steel lock strip; corners mitered, welded, and ground smooth.
3. Minimum steel sheet thickness: 22 gage.
4. Minimum panel thickness: 1 inch.
5. Coordinate with toilet room accessories specified in Section 102813; provide cutouts and internal reinforcement.

2.5 FINISHES

- A. MTL-1 Stainless Steel: : No. 4 satin.

- B. Hardware and Accessories:

1. Stainless steel: No. 4 satin.
2. Chrome plated steel: Bright polished.
3. Aluminum: Clear anodized.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved Shop Drawings.
- B. Set doors straight, plumb, level, and aligned.
- C. Provide 3/8 to 1/2 inch vertical clearances between walls and doors.
- D. Attach doors to walls using appropriate anchor devices.
- E. Equip doors with two hinges, door latch, door strike and keeper, and bumper/coat hook.

3.2 ADJUSTING

- A. Adjust hardware for proper operation.
- B. Adjust door hinges to hold door open 10 degrees when not latched.
- C. Touch up minor scratches and abrasions to match factory finish.

END OF SECTION

SECTION 102813 - TOILET ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Toilet accessories.
- B. Related Sections:
 - 1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 SUBMITTALS

- A. Submittals for Review:
 - 1. Product Data:
 - a. Schedule accessories by room; show plans and elevations, and identify room name and number, type and quantity of accessories, and mounting heights.
 - b. Include manufacturer's brochures showing sizes, details of function, finishes, and attachment methods.
 - 2. Samples: One of each accessory, if requested.
 - 3. Warranty: Sample warranty form.

1.3 QUALITY ASSURANCE

- A. Locate accessories at heights to meet applicable accessibility codes, refer to Drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Stainless Steel:
 - 1. Sheet: ASTM A666, Type 304, rollable temper.
 - 2. Tubing: ASTM A269.
- B. Galvanized Steel: ASTM A1008/1008M.

2.2 ACCESSORIES

- A. Fasteners: Stainless steel where exposed, hot dip galvanized where concealed; type best suited to substrate conditions.

2.3 FABRICATION

- A. Use stainless steel for exposed surfaces; galvanized steel may be used in concealed locations.
- B. Form exposed surfaces from single sheet of stock, free from joints, and flat, without distortion.
- C. Weld joints of fabricated components and grind smooth.
- D. Fabricate grab bars of tubing, free of visible joints, return to wall with end attachment flanges.
- E. Fabricate soap dispensers to operate with less than 5 pound force.
- F. Provide hangers, adapters, anchor plates, and accessories required for installation.
- G. Key locks alike; furnish six keys.
- H. Shop assemble units and package complete with anchors and fittings.

2.4 FINISHES

- A. Stainless Steel: No. 4 satin.
- B. Galvanizing: ASTM A123/A123M to 1.25 ounces per square foot.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Set plumb, level, square, and rigid.

3.2 SCHEDULE

MARK	DESCRIPTION	FINISH	MODEL NO.
T1	Waste receptacle, semi-recessed	Stainless Steel	
T2	Toilet tissue dispenser, surface mounted	Stainless Steel	
T3	Framed Mirror	Stainless Steel	
T4	Shelf, surface mounted	Stainless Steel	
T5	Feminine napkin disposal, surface mounted	Stainless Steel	
T6	Grab bar, 36" safety grip	Stainless Steel	
T7	Grab bar, 42" safety grip	Stainless Steel	
T8	Changing Table	Stainless Steel	
T9	Hand dryer, semi-recessed	Stainless Steel	

END OF SECTION

SECTION 123200 - MANUFACTURED CASEWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Shop fabricated wood cabinet designed for ITAV and electrical panel clearance.
 - 2. Finish hardware.
- B. Related Sections:
 - 1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 SUBMITTALS

- A. Submittals for Review:
 - 1. Shop Drawings: Include cabinet locations, large scale plans, elevations, rough-in locations, dimensions, tolerances, and clearances required.
 - 2. Product Data: Manufacturer's data showing construction details, configurations, materials, hardware, and accessories.

1.3 QUALITY ASSURANCE

- A. Cabinets:
 - 1. All cabinets shall be labeled or documented ANSI/KCMA A161.1 Certified
 - 2. Exception: Cabinets made in Kentucky do not require an ANSI/KCMA A161.1 label when pre-approved by KHC and constructed to the following specifications.
- B. Fabricator Qualifications: Minimum 3 years documented experience in work of this Section.
- C. Fire-Retardant Treated Product Requirements:
 - 1. Class C: Bear label of recognized independent testing laboratory indicating flame spread rating of 200 or less and smoke developed index of 450 or less, tested to ASTM E84 or UL 723.

1.4 PROJECT CONDITIONS

- A. Environmental Requirements: HVAC system complete and operational for minimum 7 days prior to installation of casework

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Preferred Product: Salvaged Cabinetry. Coordinate with Architect.

- B. Other Acceptable Manufacturers:
 - 1. Kabinart Kitchens. (www.kabinartkitchens.com)
 - 2. Leedo Cabinetry. (www.leedocabinetry.com)
 - 3. Republic Elite, LLC. (www.republicelite.com)
 - 4. Quality Cabinets. (www.qualitycabinets.com)

- C. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. Preferred Product: Salvaged Cabinetry. Coordinate with Architect.

- B. Alternate Product (If salvaged cabinetry is not available) – Manufactured Casework to meet following requirements.

- C. Manufactured Panel Products:

- 1. Doors, drawers, and fronts: Perform to ANSI/KCMA A161.1 standard.
- 2. Cabinet fronts: Solid wood (no particleboard or fiberboard); doors, draws and fronts shall be factory finished.
- 3. Cabinet ends: Finished with appropriate veneer.
- 4. Cabinet doors and drawers: Provide milled edges for a hand hold or handles to aid in operating the door or drawer.
- 5. Cabinet box and shelves: Constructed of cabinet grade plywood and braced at points where necessary to ensure rigidity and proper joining of various components.
- 6. Faces:
 - a. Transparent Finish: Species and cut to be selected, of quality suitable for transparent finish.

- D. Lumber:

- 1. Concealed: Softwood.
- 2. Exposed:
 - a. Transparent Finish: Species and cut to be selected, of quality suitable for transparent finish.
- 3. Average moisture content: 6 percent.

- E. Hardware:

- 1. Fasteners: Size and type to suit application.
- 2. Concealed joint fasteners: Threaded steel.
- 3. Finish hardware:
 - a. ANSI/BHMA A156.9.
 - b. Door hinges: Concealed, self-closing, adjustable.
 - c. Drawer slides: Side mounted full extension, with ball bearing nylon wheels.

2.3 FABRICATION

- A. Components:
 - 1. Concealed frames: Softwood lumber.
 - 2. Exposed front frames and end panels: Panel product.
 - 3. Backs: Melamine laminate over hardboard.
 - 4. Doors and drawer fronts: Panel product, raised panel design.
 - 5. Bottoms: Melamine laminate over particleboard.
 - 6. Shelves: Melamine laminate over particleboard, edge banded.
 - 7. Toe kicks: Plastic laminate over particleboard.
- B. Shop assemble cabinets in units of sizes and configurations indicated.
- C. Fabricate corners and joints without gaps and inaccessible spaces.
- D. Fabricate each unit to be rigid, not dependent on adjacent units for stability.
- E. Form edges smooth.
- F. Provide cutouts for fixtures and appliances.
- G. When necessary to allow for field fitting, provide materials with ample allowance for cutting. Provide trim required by site conditions.

2.4 FINISHES

- A. Exposed Wood and Plywood: Thermofoil, refer to Finish Schedule for color.
- B. Hardware: To be selected from manufacturer's standard selections.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install casework in accordance with manufacturer's instructions if applicable.
- B. Use anchoring devices suited to site conditions.
- C. Set level, plumb, and square, securely anchored to adjacent construction.
- D. Scribe casework abutting other component, with maximum 1/8 inch gaps. Use filler strips to conceal larger voids; do not overlay materials.
- E. Close ends of units, bases, shelves, and splashes.

3.2 ADJUSTING

- A. Adjust doors and drawers to operate smoothly.

- B. Touch up minor scratches and abrasions to match original finish.

END OF SECTION

SECTION 123616 - CONCRETE CONCRETE SINKS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Custom concrete sinks.
- B. Related Sections:
 - 1. Division 01: Administrative, procedural, and temporary work requirements.
 - 2. Section 079200 - Joint Sealants.
 - 3. Division 26 - Plumbing.

1.2 SUBMITTALS

- A. Submittals for Review:
 - 1. Shop Drawings: Show sink design and relationship to adjacent construction.
 - 2. Product Data: Manufacturer's descriptive data for sink and accessories.
 - 3. Samples: 12 x 12 inch concrete samples, sealed and waxed, illustrating color and finish.

PART 2- PRODUCTS

2.1 MANUFACTURERS

- A. Contract documents are based on products by Trueform Concrete (www.trueformconcrete.com)
- B. Substitutions: Under provisions of Division 01.

2.2 MATERIALS

- A. Custom Concrete Sink:
 - 1. Source: Custom Sink by Trueform, or approved substitute
 - 2. Design: Refer to Drawings.
 - 3. Contact: jenny.radley@trueformconcrete.com

2.3 ACCESSORIES

- A. Sealer and Wax: Type recommended by manufacturer for application.
- B. Sink supports and attachments: Type recommended by manufacturer for application.
- C. Joint Sealant: Specified in Section 079200.

2.4 FABRICATION

- A. Fabricate sinks to match approved Shop Drawings and samples.

- B. Construct rigid, tight molds that will cast required sections with smooth finish.
- C. Provide smooth fillet on interior corners of molds to produce slight beveled edge on permanently exposed surfaces.
- D. Clean surfaces of foreign materials prior to casting.
- E. Coat contact surfaces with form release agent.
- F. Fabricate units in sizes easily transported, ready for delivery to site.
- G. Cast units with integral reinforcing.
- H. Tamp or vibrate concrete to produce dense units with smooth surfaces, free from air pockets and voids.
- I. Color: To be selected by Architect.
- J. Finish surfaces with smooth trowel finishes free from voids, trowel marks, and other defects.
- K. Fabrication Tolerances:
 - 1. Maximum variation from plane: Plus or minus 1/8 inch in 10 feet.
 - 2. Maximum out of square: 1/8 inch in 10 feet.
 - 3. Maximum variation from dimensions indicated: Plus or minus 1/4 inch.
 - 4. Maximum misalignment of openings: 1/4 inch.
 - 5. Bowing: Maximum L/360.

PART 3

PART 4- EXECUTION

4.1 INSTALLATION

- A. Set units level and aligned.
- B. Secure to substrate in accordance with manufacturer's instructions.
- C. Apply joint sealant to joints between sink and adjacent construction, under provisions of Section 079200.
- D. Connect to plumbing per Plumbing Drawings and Specifications.

END OF SECTION

SECTION 129300 - SITE FURNISHINGS

PART 1 GENERAL

1.1 SUMMARY

- A. Provide all materials and equipment, and do all work necessary to furnish and install the site furnishings, including drinking fountains and bollards, etc., as indicated on the Drawings and as specified.

1.2 RELATED WORK

- A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:
 - 1. Section 033000, CAST-IN-PLACE CONCRETE - SITEWORK; Poured in place concrete foundation.
 - 2. Section 321313, CONCRETE PAVING.
 - 3. Section 321440, STONE PAVING VENEER.

1.3 REFERENCES

- A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.
 - 1. American Society for Testing and Materials (ASTM):
 - A 153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware

1.4 SUBMITTALS

- A. Complete shop drawings of each item specified shall be submitted.
- B. Where appropriate, and when approved by the Architect, manufacturer's catalogue cuts may be substituted for shop drawings.
- C. Submit assembly instruction drawings showing layout(s), connections, bolting and anchoring details as per manufacturer's standards.
- D. Submit manufacturer's recommended maintenance and winterization procedures.
- E. Manufacturer's Review: Submit written statement, signed by furnishing manufacturer stating that Drawings and Specifications have been reviewed by qualified representatives of furnishing manufacturer, and that they are in agreement that exposed fasteners and hardware to be used in the furnishing item is in compliance with Current Consumer Product Safety Commission (CPSC) guidelines issued in "A Handbook for Public Playground Safety" (latest edition).

1.5 DESIGN CERTIFICATION REQUIREMENT

- A. Engineering: Provide services of Professional Engineer, registered in the State of Rhode Island to stamp and sign concrete footing design for basketball hoop.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Materials shall be the standard products of a manufacturer regularly engaged in the manufacture of such products. The materials provided shall be of a type with proven satisfactory usage for at least 2 years.

2.2 FASTENERS AND HARDWARE

- A. Provide fastener and hardware materials indicated on the Drawings and specifications as required for assembly of units and as indicated on the assembly drawings. Provide unexposed aluminum, stainless steel or steel plates, angles and supports as required for complete assembly. Separate dissimilar materials to prevent electrolytic action.

1. Fasteners and metal components shall be Type 304 stainless steel, cadmium-plated steel or steel hot-dipped galvanized in accordance with ASTM A 153.
2. Galvanized steel surfaces shall be hot-dip galvanized. Provide coating for iron and steel fabrications applied by the hot-dip process, Duragalv[®] by Duncan Galvanizing, or approved equal. Comply with ASTM A 123 for fabricated products and ASTM A 153 for hardware. Provide thickness of galvanizing specified in referenced standards. The galvanizing bath shall contain special high grade zinc, nickel, and other earthly materials.

2.4 FURNISHINGS

- A. Refer to the Schedules on the Drawings. :

PART 3 EXECUTION

3.1 GENERAL

- A. The Contractor shall verify that finished grades and other operations affecting mounting surfaces have been completed prior to the installation of site furnishings. Site furnishings shall be installed plumb and true, at locations indicated, in accordance with the approved manufacturer's instructions.

3.2 ASSEMBLY AND ERECTION OF COMPONENTS

- A. Items shall be shipped knocked-down (KD) ready for site assembly. Packaged components shall be complete including all accessories and hardware. New parts shall be acquired from the manufacturer; substitute parts will not be accepted unless approved by the manufacturer. When

the inspection of parts has been completed, the site furnishings shall be assembled and anchored according to manufacturer's instructions or as indicated. When site furnishings are assembled at the site, assembly shall not interfere with other operations or pedestrian and vehicular circulation.

3.3 ANCHORAGE, FASTENINGS AND CONNECTIONS

- A. Furnish metal work, mounting bolts or hardware in ample time for securing into concrete or masonry as the work progresses. Provide anchorage where necessary for fastening furniture or furnishings securely in place. Provide, for anchorage not otherwise specified or indicated, slotted inserts, expansion shields, and power-driven fasteners, when approved for concrete; toggle bolts and through bolts for masonry; machine and carriage bolts for steel; through bolts, lag bolts, and screws for wood. Provide non-ferrous attachments for non-ferrous metal. Make exposed fastenings of compatible materials, generally matching in color and finish the fastenings to which they are applied. Conceal fastenings where practicable.

3.4 TESTING

- A. Each site furnishing shall be tested to determine a secure and correct installation. A correct installation shall be according to the manufacturer's recommendations and by the following procedure: The Contractor shall measure the physical dimensions and clearance of each installed site furnishing for compliance with manufacturer's recommendations and as indicated. Site furnishings which do not comply shall be reinstalled. Fasteners and anchors determined to be non-compliant shall be replaced. A written report describing the results of the testing shall be provided.

3.5 FURNISHINGS

- A. Work shall be executed only by workmen experienced in the trade.
- B. Examine areas to receive furnishings and athletic equipment. Notify Architect of conditions that would adversely affect installation or subsequent use. Do not begin installation until unacceptable conditions are corrected
- C. Coordinate installation with installation of the surrounding surface at grade beneath the furnishings and athletic equipment.
- D. Installation
 - 1. Install furnishings and athletic equipment in accordance with manufacturer's instructions at locations indicated on the Drawings.
 - 2. Install level and plumb.
- E. Adjusting
 - 1. Finish Damage: Repair minor damages to finish in accordance with manufacturer's instructions and as approved by Architect.
 - 2. Component Damage: Remove and replace damaged components that cannot be

successfully repaired as determined by Architect.

F. Cleaning

1. Clean promptly after installation in accordance with manufacturer's instructions.
2. Do not use harsh cleaning materials or methods that could damage finish.
3. Protect surrounding paving and wood decking during cleaning.

G. Protection

1. Protect furnishings and athletic equipment from paint spatter, splashed concrete, and other construction damage by wrapping and taping in place plastic sheeting or heavy kraft paper until adjacent work is completed.
2. Protect furnishings and athletic equipment to ensure that, except for normal weathering, they will be without damage or deterioration at time of Substantial Completion.

END OF SECTION

DIVISION 22

Plumbing

95% Construction Documents

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Mechanical sleeve seals.
 - 3. Sleeves.
 - 4. Escutcheons.
 - 5. Grout.
 - 6. Equipment installation requirements common to equipment sections.
 - 7. Painting and finishing.
 - 8. Concrete bases.
 - 9. Supports and anchorages.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. CPVC: Chlorinated polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Mechanical sleeve seals.
 - 2. Escutcheons.
- B. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Panels."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining CPVC Plastic Piping: ASTM F 493.

2.4 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Carbon steel. Include two for each sealing element.

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

2.5 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.6 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 1. Finish: Polished chrome-plated.
- E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With concealed hinge, screw or spring clips, and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.7 GROUT

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

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

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
 - f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

- M. Sleeves are not required for core-drilled holes.
- N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
 - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.
- R. Verify final equipment locations for roughing-in.
- S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

3.3 PAINTING

- A. Painting of fire-suppression systems, equipment, and components is specified in Division 09 Section "Painting and Coating."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.4 CONCRETE BASES

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

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

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.6 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.7 GROUTING

- A. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

3.8 DEMOLITION AND RELOCATION

- A. The Contractor shall modify, remove, and 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. Salvage materials except asbestos shall remain the property of the Owner, and shall be delivered to such destination as directed by the Owner. Non-salvageable materials and equipment shall become the property of the Contractor and removed from the site.
- B. Asbestos abatement is being performed under a separate contract. There have been no tests for existence of asbestos or other potentially hazardous materials within this facility. The Contractor shall immediately notify the Owner of any area where the Contractor suspects or becomes aware of the existence of asbestos or other potentially hazardous materials on this project. It shall be the responsibility of the Contractor to provide written request to the Owner for the services of an Industrial Hygienist who shall provide all necessary testing, analysis and documentation of the status of any areas where asbestos or potentially hazardous materials exist. The Industrial Hygienist shall then prepare plans and specifications which provide for the removal of all potentially hazardous substances and their disposal in a lawful manner. The Contractor shall not remove or disturb asbestos or other potentially hazardous substances until he has obtained approval in writing of the methods he shall use from the authorities having jurisdiction.
- C. 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 relocation 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. Where items scheduled for relocation and/or reuse 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 or the Architect and Engineer. The Contractor may, at his discretion, and upon the approval of the Owner, substitute new materials and items of like design and quality in lieu of materials and items to be relocated.
- D. Service lines and wiring to items to be removed, salvaged, or relocated shall be removed to points 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.
- E. Cleanup: It shall be the responsibility of each trade to cooperate fully with the other trades on the job to keep the jobsite 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.

END OF SECTION

220510 - COMMON REQUIREMENTS for PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The requirements set out in Bidders Documents, Contract Forms, General Conditions, Supplementary General Conditions and Special Conditions apply to all work specified in the sections of this division.
- B. A division is a group of related sections and a section covers one portion of the total work or requirements. It describes a particular material or product and its installation.
 - 1. A section does not necessarily relate to the work accomplished by a single subcontractor. It is not the intent of the Specifications to define the work of individual trades so that a contractor can simply hand out various sections to selected subcontractors. Each contractor will subdivide the work differently among subcontractors. It is not possible for the Specifier to know which contractor may be the successful bidder and how the project will be managed.
 - 2. For the above reasons, the text of sections, and the Specifications in general, are always addressed to the Contractor and not to subcontractors. The Contractor signs an agreement with the Owner to construct the project and therefore is the only one responsible to the Owner. Responsibility for the total project remains with the Contractor no matter how the work is divided among subcontractors.
- C. Work covered by the Mechanical Sections of these Specifications shall include the furnishing of all materials, labor, taxes, transportation, safe working conditions, tools, permits, fees, inspections, utilities and incidentals necessary for the complete and operable installation of all mechanical systems.
- D. Under these Contract Documents, the Contractor shall provide an installation that is complete in every respect. The Contractor shall include additional details or special construction as required for work indicated or specified in this section or work specified in other sections. It shall be the responsibility of the Contractor to provide all material and equipment which is usually furnished with such systems in order to complete the installation, whether mentioned or not.
- E. The Contractor shall be responsible for the coordination and proper relation of the work to the building structure and to the work of all trades. The Contractor shall visit the premises and become familiar with the existing site conditions, and all details of the work and the working conditions and to verify all dimensions and elevations in the field. The Contractor shall advise the Architect and the Engineer of any discrepancy prior to bidding. The submission of bids shall be deemed evidence of the Contractor's site visit, the verification and coordination of all existing conditions, and the inclusion of all considerations related to the existing conditions.
- F. The responsibility for the furnishing of the proper equipment and/or material and the responsibility for seeing that it is installed as intended by the manufacturer rests entirely upon the Contractor. The Contractor shall consult and request advice and supervisory assistance from

the representative of the specific manufacturer for proper installation, operation, and startup. The manufacturers' published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning manufactured materials or equipment. The Contractor shall promptly notify the Architect and the Engineer in writing of any conflict between the requirements of the contract documents and the manufacturers' directions and shall obtain the Architect's and 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 and Engineer, he shall bear all resulting costs that may arise from any system or equipment deficiencies.

1.3 DRAWINGS AND SPECIFICATIONS

- A. These Specifications are accompanied by Drawings of the building and details of the installations indicating the locations of equipment, piping, ductwork, outlets, light fixtures, etc. Items specifically mentioned in the Specifications but not shown on the Drawings and items shown on the Drawings but not specifically mentioned in the Specifications shall be installed by the Contractor under the appropriate section of work as if they were indicated by both.
- B. If departures from the Drawings are deemed necessary by the Contractor, details of such departures and the reasons therefor shall be submitted to the Architect and the Engineer for review. No departures shall be made without prior written acceptance of the Architect and the Engineer.
 - 1. The interrelation of the Specifications, the Drawings, and the schedules is generally 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.

1.4 SUBMITTALS

- A. After the Contract is awarded, but prior to proceeding with the Work, the Contractor shall obtain, check, certify, and submit complete Shop Drawings and Brochures from Manufacturers, Suppliers, Vendors, etc., for all materials and equipment specified herein. Submit Shop Drawings and Brochures in sufficient time so as not to impede the progress of Work. Four weeks will be required for the processing of Shop Drawings and Brochures in the Engineer's office, exclusive of transmittal time. This time shall be considered by the Contractor when scheduling submittal data. After the Contract is awarded, the Contractor will advise the Engineer in writing of the schedule for submission of shop drawings and product data and the persons authorized to sign submittal data on behalf of the Company.
- B. The Engineer's review of Shop Drawings and Brochures shall not relieve the Contractor of the responsibility for dimensions, errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the Engineer's noting some errors but overlooking others does not grant the Contractor permission to proceed in error. Contractor shall refer to Section 230593 for all test and balance rough-in requirements. Contractor shall ascertain all equipment electrical requirements are coordinated with Division 26 and electrical drawings. Contractor shall confirm all shop drawings reflect coordination with structural and all other trades and are free of interferences. Regardless of any information contained in the Shop Drawings, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the submittal data review.
- C. Before submission of Shop Drawings and Brochures, the Contractor shall certify that each Shop

Drawing and each item of material or equipment complies with the Contract Documents for this Project. Such certification shall be made by the Owner, a Partner, a Corporate Officer of the Contractor, or by a person duly authorized to sign for the Contractor. Unless so certified, Shop Drawings and/or Brochures will be returned for resubmittal. Certifications shall be in the form of rubber stamp impressions or typed letter which states:

I hereby certify that this Shop Drawing and/or brochure and the equipment and material shown on this Shop Drawing and/or Brochure complies in all respects (except as noted*) with the requirements of the Contract Documents for this Project. I further certify that all data shown herein as to performance, dimensions, construction, materials, and other pertinent items are true and correct.

(Name of Contractor) _____
Signed _____
Position _____
Date _____
* Refer to exception requirements herein.

D. Each Shop Drawing shall indicate in the lower right hand corner and each Brochure shall indicate on the front cover the following: Title of the Sheet or Brochure; name and location of the building; names of the Architect, Engineer, Contractor, Manufacturer, Supplier, Vendor, etc., the date of submittal; and the date of each correction and revision. So far as is practical, each Shop Drawing and/or Brochure shall bear a cross-reference note to the sheet number or numbers of the Contract Drawings and Specifications showing the same work. Shop Drawings and Brochures shall be prepared as follows:

1. Shop Drawings: Drawings shall be newly prepared and not reproduced from the contract documents, drawn to a scale that can be easily read and shall contain sufficient plans, elevations, sections, and isometrics to describe clearly the items in question. Drawings shall be prepared by a draftsman skilled in this type of work. All piping, equipment layouts, ductwork and similar Shop Drawings shall be drawn to at least 1/4" = 1'-0" scale.
2. Brochures: Brochures submitted to the Engineer shall be published by the Manufacturers and shall contain complete and detailed engineering and dimensional information to show that the equipment will fit into the allotted space.
3. Brochures submitted shall contain only information which is relevant to the particular equipment and applicable accessories that are required for sale and efficient operation of the systems or materials to be furnished. Do not submit catalogs that describe several different items other than those items to be used unless all irrelevant information is marked out or relevant information is clearly marked.

- E. The submittal format shall follow the Specifications format with a submittal required for each section of Division 22. The submittal shall be contained in a three-ring hard back binder. Copies of each submittal shall be three-hole punched and arranged (or folded if required) for the Engineer's filing convenience. Provide one copy of updated TABLE OF CONTENTS and progressive-tabbed index sheets also for the Engineer's filing convenience.
- F. Any submittals that do not meet the items listed in sub-section 1.03 D above will be returned without review. The contractor shall be responsible for costs related to additional reviews of items returned without review for cause.
- G. Submittal data for each section must be complete. Partial submittals will not be reviewed. To the greatest extent possible all sections shall be submitted with the first submission. No more than three additional submissions will be allowed to complete the submittal package.
- H. Mechanical and Plumbing contractor shall be responsible for submitting a coordinated RCP shop drawing showing ALL ceiling mounted devices such as the lights, air devices, fire alarm devices, special systems devices, and sprinkler heads. Drawing shall be submitted to Architect/Engineer for review prior to installation of devices.
- I. Unless a greater number is indicated within the Architectural Sections of these specifications, submit a digital copy of all Brochures for review. Comments will be made on the reproducible to facilitate copying. Submittals in computerized transmittal in acceptable formats are optional provided the Architect and Engineer have no objection to the contractor's submittal in computer document formats.
- J. Minimum size of submittal data shall be 8-1/2 x 11".
- K. Any submittal that is disapproved must be resubmitted within two (2) weeks following notification of such disapproval. If no satisfactory material is submitted within the two-week period, the Architect and the Engineer reserves the right to require the Contractor to furnish items exactly as described in the Contract Documents.
- L. No allowances will be made for submittals which are not made in a timely fashion or which are turned down because they do not meet the specifications. Should delivery problems arise due to the above, affecting the completion time of the project, the Contractor will furnish and install acceptable alternates until the proper materials arrive and then replace the alternate materials with the approved materials, all at no cost to the Owner. If the Contractor is not able to furnish an acceptable alternate until the proper materials arrive, he will assume all costs for furnishing and installing all alternates as directed by the Architect and/or will pay a suitable penalty for the inconvenience experienced by the Owner. This penalty will be set by the Owner based on the particular circumstances.
- M. Only equipment and material brands which are specifically mentioned in the following sections of Division 22 will be considered during the submittal process.

1.5 RECORD DRAWINGS

- A. The Contractor shall maintain on a daily basis at the project site a complete set of "Record Drawings", reflecting an accurate dimensional record of all buried or concealed work. The "Record Drawings" shall also consist of a set of blueline or blackline prints of the final "Signed Off" Contractor's Coordination Drawings" prepared by the Subcontractors. In addition, the "Record Drawings" shall be marked to show the precise location of concealed work and

equipment, including concealed or embedded piping and valves and all changes and deviations in the Mechanical work from that shown on the Contract Documents. This requirement shall not be construed as authorization for the Contractor to make changes in the layout or work without written definite instructions from the Architect and the Engineer.

- B. Daily Record Drawings: The Daily "Record Drawings" shall consist of a set of blue-line or black-line prints of the Contract Drawings for this Division with the Engineer's seal and Engineer's firm name removed or blacked out. Final "Record Drawings" shall be electronic CAD files. Prior to commencing work, the Contractor shall purchase from the Architect and the Engineer a set of blue-line or black-line prints to be used for the daily "Record Drawings."
- C. Final Record Drawings:
1. Prior to completion of the construction, the Contractor may purchase electronic copies of the floor plans in AutoCAD format for use in developing the Record Drawings from the Engineer if he is the Prime Consultant or from the Architect. If CNG Engineering, PLLC, is the Prime Consultant, these electronic drawings will be made available at a cost of \$75.00 per sheet providing an Officer of the Contractor's firm signs a liability release.
 2. Final Record Drawings in AutoCAD format shall comply with the following:
 - a. A CADD file that matches the plotted sheet shall be provided to CNG Engineering, this sheet may contain Xreferences linking to the full size design files. The filename of this plotted sheet shall match the sheet number represented in the title block of that sheet.
 - b. All CADD files are to be drawn to full size scale, and all elements are to be drawn full size, except where size constraints will not allow the exact dimension, in this case a standard symbol should be used in its place, i.e., an electrical outlet should be a symbolic symbol, whereas a 2'x4' light fixture should be drawn 2'x4'.
 - c. Reproducible hardcopy plots shall accompany transfer of electronic media. Verify plotted sheet size with CNG Engineering prior to plotting. Each plotted sheet shall have a corresponding electronic CADD file associated with it.
 - d. All CADD design file documents are to be drawn relative to each other with one common origin point universally defined as absolute zero (0,0,0) on a plan view.
 - e. The CADD layering scheme shall be such that specific design elements and text can be isolated via layer ON/OFF control. A printed list shall be provided detailing layer name and description of design elements for each layer.
 - f. Contractor shall provide to CNG Engineering all non-standard AutoCAD fonts used in the CADD documents. If specialized fonts with characters of ASCII value greater than 126 are used, Contractor shall convert them to graphic lines, circles, arcs, etc. and or blocks, removing the special coded text string.
 - g. When X-references are used in the CAD drawings, all support CAD drawings shall remain as X-ref attachments (not bound) to ensure uniformity of layer names, text style names, block names, linetypes names and origin base point. A diagram shall be provided, detailing the exact flow of all X-ref's. Remove all path names from all attached Xref's so that all files can be in one directory and be resolved into AutoCAD.
 - h. All media shall be accompanied by a printed indexed listing of the contents.
 - i. If the amount of compressed CAD data exceeds fifty (50) megabytes, contact the CADD/Computer Coordinator at CNG Engineering for further arrangements for transfer of electronic data.
 - j. Contractor shall provide CAD files and reproducibles of Record Drawings within

15 working days of notification from CNG Engineering, in a form satisfactory as described above.

- k. Engineer and/or Owner reserves the right to review CAD files of Record Drawings at any time during construction. If this agreement is terminated, the Contractor shall promptly furnish CAD files as is to that date to CNG Engineering and/or Owner.
- D. Record dimensions shall clearly and accurately delineate the work as installed, including horizontal and vertical offsets (with elevations) of underground services. Locations shall be suitably identified by at least two (2) dimensions to permanent structures.
- E. The Contractor shall mark all "Record Drawings" on the front lower right hand corner with a rubber stamp impression that states the following:

"RECORD DRAWINGS
(3/8" high letters)
To be used for recording Field Deviations
And Dimensional Data Only."
(5/16" high letters)

- F. Upon completion of work, the Contractor shall certify the "Record Drawings" for correctness by signing the following certification:

CERTIFIED CORRECT (3/8" high letters)

(Name of General Contractor)

By: _____

Date: _____

(Name of Mechanical, Plumbing, Fire
Protection or Temperature Control Subcontractor)

By: _____

Date: _____

- G. Prior to final acceptance of the Work of this Division, the Contractor shall submit properly certified "Record Drawings" to the Architect and the Engineer for review and shall make changes, corrections, or additions as the Architect and the Engineer may require to the "Record Drawings." After the Architect and the Engineer review, one set of reproducible mylars and one (1) set of electronic CAD files (AutoCAD) "Record Drawings" shall be delivered to the Owner.

1.6 RECORD SPECIFICATIONS

- A. Maintain and submit Record Specifications as required in Division 01 Specification– CONTRACT CLOSEOUT.

1.7 SPACE LIMITATIONS

- A. Equipment has been chosen which will fit into the physical spaces provided and indicated, allowing ample room for access, servicing, removal and replacement of parts, etc. Adequate space shall be allowed for clearance in accordance with the Code requirements and the requirements of the local inspection department.
- B. In the preparation of Drawings, a reasonable effort to accommodate approved Equipment Manufacturers' space requirements has been made. However, since space requirements and equipment arrangement vary according to each Manufacturer, the responsibility for initial access and proper fit rests with the Contractor.
- C. Physical dimensions and arrangements of equipment to be installed shall be subject to the Architect's review.
- D. All mechanical equipment specified herein and shown on the Drawings is schematic. Prior to beginning any work whatsoever, the Division 22 Mechanical Contractor shall furnish as a part of the mechanical equipment submittals, scaled drawings of all proposed mechanical equipment, indicating accurate sizes and characteristics of proposed equipment, as well as clearances, piping routes, and all other details as required to allow the Engineer, Architect, and Owner the opportunity to approve the proposed layout and equipment. If the arrangement is not acceptable, then the proposed equipment and/or arrangement shall be modified or changed as required to be made acceptable at no additional cost to the Owner.

1.8 CONTRACTOR'S COORDINATION DRAWINGS

- A. The Contractor and all Subcontractors shall prepare a complete set of "Coordination Drawings" indicating the equipment actually purchased and the exact routing for all lines such as piping, conduit and ductwork. The elevation, location, support points, load imposed on the structure at support and anchor points, and size of all lines shall be indicated. All beam penetrations and slab penetrations shall be indicated and sized and shall be coordinated. This requirement for "Coordination Drawings" shall not be construed as authorization for the Contractor or Subcontractor to make any unauthorized changes to the Contract Drawings. All Design Drawing space allocations shall be maintained, such as ceiling height, chase walls, equipment room size, etc., unless proper written authorization is received from the Architect to change them.

1.9 OPERATION AND MAINTENANCE MANUAL

- A. Prepare and submit to the Architect and the Engineer for delivery to the Owner two (2) sets of an indexed manual with complete technical data for every piece of equipment and material installed under this Contract.
 - 1. Complete mechanical submittals that were approved for the project.
 - 2. Manufacturer's installation instruction brochures.
 - 3. Manufacturer's local representative and/or distributor's name and address.
 - 4. Manufacturer's operation and maintenance brochures.
 - 5. Manufacturer's internal wiring diagrams.
 - 6. Contractor's installation wiring diagrams.
 - 7. Control system installation Drawings and typed control sequences.

8. Replacement part number listings and/or descriptions including prices and source of supply.
 9. Lubrication materials required, with instructions.
 10. Valve tag list and schematic diagram.
 11. All warranties and guarantees.
 12. Testing and Balancing Report.
 13. Commissioning Report.
 14. Provide the above item 1 through 13 in separate binders.
- B. These manuals shall include all of the listed data bound into permanent hard-back binders identified on the cover with applicable name per list above. Provide a title page listing the name and location of the Building, the Owner, the Architect, the Engineers, the General Contractor, and the Trade-Contractors installing equipment represented in the brochure.
- C. Contents of the manual shall be grouped in sections according to the various sections of Division 22, and shall be listed in a Table of Contents.

1.10 QUALITY ASSURANCE

- A. Should the Drawings disagree in themselves or with the Specifications or with the various codes and regulations, the better quality or greater quantity of work or materials shall be assumed and estimated, and unless otherwise directed by the Architect and the Engineer in writing, shall be performed or furnished. In case the Specifications should not fully agree with the schedules, the latter shall govern. Figures indicated on Drawings govern scale measurements and large scale details govern small scale Drawings.
- B. The Contractor shall comply with all applicable jurisdictional authority requirements including but not limited to city, county, state, or federal rules, codes and ordinances.
- C. None of the terms or provisions of this Specification shall be construed as waiving any rules, regulations, or requirements of these authorities.
- D. A competent foreman or superintendent, initially approved by the Architect and the Engineer, shall be kept by the Contractor at the building to receive instructions and to act for the Contractor. Once this superintendent has been approved, no change shall be made without approval of the Architect and the Engineer. Owner's representatives shall have the right to observe the work at any time. The Contractor shall have a representative present when his work is being observed, and he shall give assistance, as may be required, to the Architect's and the Engineer's representative. Recommendations made shall be promptly carried out, and all unsatisfactory material and/or workmanship shall be replaced at once, to the satisfaction of the Architect and the Engineer.
- E. It shall be the responsibility of the Contractor to consult the Architectural and Engineering Drawings and details so as to thoroughly familiarize himself with the type and quality of construction to be provided on this project.
- F. The Plumbing Drawings are diagrammatic in character and cannot show every connection in detail or every pipe and equipment in its exact location. These details are subject to the requirements of codes, ordinances and also electrical, structural and architectural conditions. The Contractor shall carefully investigate all electrical, structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be laid out so that it will be concealed in furred chases or above suspended

ceilings, etc., in finished portions of the building, unless specifically noted or indicated to be exposed. Work shall be installed to avoid crippling of structural members; therefore, inserts to accommodate hangers shall be set before concrete is poured, and proper openings through floor, walls, beams, etc., shall be provided as hereinafter specified or as otherwise indicated or required before concrete is poured. All work shall be run parallel or perpendicular to the lines of the building unless otherwise noted.

- G. The approximate location of each item is indicated on the Drawings. These Drawings are not intended to give complete and exact details in regard to location. Exact locations are to be determined by actual measurements at the building and will in all cases be subject to the approval of the Architect. The Architect and the Engineer reserves the right to make reasonable changes in the locations indicated without additional cost.

1.11 DELIVERY, STORAGE AND HANDLING

- A. The Contractor shall not receive material or equipment at the job site until ready for installation or until there is suitable space provided to properly protect equipment from rust, weather, humidity, dust, or physical damage.

1.12 UTILITIES

- A. The Contract Documents reflect the general location, size, and elevations of sewer line, location, size and pressure of water and other lines and manner of routing for all utilities known to be required on this project. It shall be the responsibility of the Contractor to visit the site, meet with the local utility companies in order to coordinate and confirm the exact requirements for each utility to provide a complete and operative system. The bid submitted by the Contractor shall include costs for all such coordinative work, as well as any and all utility company charges and/or fees.

1.13 TEMPORARY SERVICES

- A. It shall be the responsibility of the Contractor to provide a temporary system for each utility that is required during construction with all such temporary utility costs being billed to the Contractor.

1.14 WARRANTIES AND GUARANTEE

- A. The Contractor shall guarantee all materials and workmanship for a period of twelve (12) months after the final acceptance of work.
- B. See Division 01 Specification Section – WARRANTIES for additional requirements regarding warranties.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. The specifications contain the names of manufacturers, which are considered acceptable based on the quality of the product.
- B. Where acceptable manufacturers are listed, only products of those manufacturers may be provided. Additionally, the product must meet all the detailed requirements of the

specifications.

- C. If no manufacturer's name is mentioned, the Contractor shall provide equipment and material which meet the specifications.
- D. The Drawings represent the manufacturer's equipment scheduled. The listing of acceptable manufacturers in the specifications is not intended to imply that equipment of these other manufacturers will fit in the space provided or have the same electrical, structural or other requirements as the equipment scheduled. The Contractor must insure that the equipment provided will meet all project requirements prior to submitting data on that equipment.

2.2 MATERIALS AND EQUIPMENT

- A. All materials shall be listed, inspected, and approved by the Underwriters Laboratories and shall bear the UL label where labeling service is available. The label or listing of the Underwriters Laboratories, Inc. will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this listing, the Contractor may submit a statement from a nationally recognized, adequately equipped testing agency, indicating that the items have been treated in accordance with required procedures, and that the materials and equipment comply with all contract requirements.
- B. Materials and equipment shall be new and shall be the standard catalog products of manufacturers regularly engaged in the manufacture of products conforming to these Specifications, and shall essentially duplicate materials and equipment that have been in satisfactory use at least two years prior to bid opening. Where custom or special items are required, these shall be fully described using Drawings, material lists, etc., which fully describe in detail the item proposed for use on this project.
- C. All metallic materials shall be protected against corrosion. Exposed metallic parts of outdoor apparatus made of ferrous metals but not of corrosion-resistant steel, shall be zinc-coated in accordance with ASTM A123 or A153, except where other equivalent protective treatment is specifically approved in writing.
- D. Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of start-up or other overload conditions. Where approved equipment requires electrical power other than those used for design purposes, the Contractor shall be responsible to adjust protective devices, starter sizes, conductors, conduits, etc. to accommodate this approved device electrically.
- E. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of final inspection.
- F. All pipe, fittings, appurtenances, and other material required for complete installation of these systems shall be new to conform to manufacturer's recommendations, unless otherwise specified. All equipment injured or damaged in transit from factory, during delivery to premises, while in storage on premises, while being erected and installed, and while being tested, until time of final completion, shall be replaced by this Contractor without extra cost to the Owner. Scratched equipment shall be repainted with factory paint to match existing or cold galvanized as required.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All equipment shall be installed in a manner to permit access to parts requiring service without disassembly of piping mains and other equipment. Access panels or doors shall be coordinated with the Architect and the Engineer and provided where necessary to permit valve equipment service or removal. Refer to the architectural specifications for additional requirements.
- B. This contract includes many different systems furnished and installed by different trades. Each trade shall coordinate their work with that of all other trades so that it may be installed in the most direct and workmanlike manner without hindering or handicapping any other trades. Where space requirements conflict, the following order of precedence shall, in general, be observed:
 - 1. Building lines.
 - 2. Structural members.
 - 3. Soil and drain piping.
 - 4. Vent piping.
 - 5. Refrigerant piping.
 - 6. Condensate piping.
 - 7. Electrical bus duct.
 - 8. Supply ductwork.
 - 9. Exhaust, return, and outside air ductwork.
 - 10. Fire sprinkler piping.
 - 11. Circulating water piping.
 - 12. Domestic hot and cold water piping.
 - 13. Natural gas piping.
 - 14. Electrical conduit.
- C. Minimize installation of water piping in proximity of rooms housing telephone equipment, fire alarm systems, transformers, or other electrical equipment. Do not install water piping within, or above ceilings of these rooms.

3.2 EXCAVATION AND BACKFILL

- A. The Contractor shall perform all excavation of every description required in the execution of his work. Excavation shall be through whatever substance encountered, to the depths indicated on the Drawings, or as required. Excavated material suitable for backfill shall be piled in an orderly manner a sufficient distance from the trench to prevent overloading sides and cave-ins. Excavated materials not suitable for backfill shall be removed from the site or stored as directed. Grading shall be done to protect the excavation from surface water. Trenches shall be maintained in a dry condition by bailing, pumping, or other approved methods. Pipe shall not be laid in wet trenches. Sheeting and shoring shall be provided as required for the protection of the work and the safety of personnel.
- B. Trenches shall be of the necessary width and depth to provide for proper laying of pipe and appurtenances, with banks as nearly vertical as possible. Bottoms of trenches shall be excavated to the grade and depth indicated or required, and barrel of pipe shall be laid on a minimum 12 inch sand bed. Bell holes, of a size to permit proper make-up of grading, shall be provided as required. For projects located over the Edward's Aquifer Re-Charge Zone, comply with City of San Antonio Plumbing Code requirements. Existing underground piping shall be protected from

damage during excavation and backfilling, and if damaged, shall be repaired to the Architect's and the Engineer's satisfaction, at the Contractor's expense. Provide 3,000 pound concrete of 3 inch minimum enclosure around lines that cross electrical utility lines or telephone cables.

- C. Trenches shall not be backfilled until all required tests have been performed. This requirement does not preclude sectional testing and backfilling of the various systems. Trenches shall be carefully backfilled with approved sand, free from large earth clods, rocks, and/or foreign materials, laid in 6 inch layers, moistened thoroughly, and carefully rammed to an elevation of one foot above top of pipe. The remainder of the backfill to finish grade shall be placed in one foot layers soaked with water, and well tamped. Under roadways, backfill to bottom of road bed material with sand only. Where settlement occurs, trenches shall be re-opened to depth required for proper compaction, refilled, and compacted.
- D. Open trenches abutting foundation or basement excavations, building walls, and grade beams, will not be permitted, but shall be backfilled and completed, for a distance of not less than 10 feet from the above features, as soon as possible. All damage resulting from flooding or other stresses due to open trenches shall be paid for by the Contractor.
- E. Where excavation requires, existing walks, street, drives, or other existing pavement to be cut to install new lines and to make new connections to existing lines, the size of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new materials is completed and the excavation has been backfilled, the paving shall be patched, using materials to match those cut out. The patches shall be thoroughly bound with the original surfaces, and shall be level with them.

3.3 CUTTING AND PATCHING

- A. Where it becomes necessary to cut through any wall, floor, or ceiling to permit installation of any work under this section of the Specifications or to repair any defects that may appear, up to the expiration of the guarantee period, such cutting shall be done under the supervision of the Architect and the Engineer by the Contractor. The Contractor shall not be permitted to cut or modify any structural members without the written permission of the Architect and the Engineer.
- B. Patching of all openings cut by the Contractor, or repairing of any damage to the work of other trades occasioned by cutting operations, or occasioned by the failure of any part of work installed under this contract, shall be performed by the trade whose work is involved, but shall be paid for by the Contractor.
- C. Any openings cut 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 cut through walls below grade shall be properly protected to prevent entrance of water or other damaging elements.

3.4 HOISTING, SCAFFOLDING, AND TRANSPORTATION

- A. The Contractor shall provide his own hoisting facilities and scaffolding to set his materials and equipment in place, as indicated on Drawings and for subsequent cleaning, testing, and adjusting.
- B. The Contractor shall provide necessary transportation to facilitate the delivery of all materials, equipment, tools, and labor to the job, in accordance with intent of these documents.

3.5 CLEANING

- A. The Contractor shall at all times, keep the premises free from accumulations of waste material or rubbish caused by him, his employees, or his work. This debris shall be removed, not only from the building, but also from the project site.
- B. At completion of the job, the Contractor shall remove all of his tools, scaffolding, and surplus materials. He shall leave the area "broom clean."

PART 4 – REGULATORY REQUIREMENTS

4.1 RELATED SECTIONS

- A. Applicable section of Division 01.

4.2 AUTHORITY HAVING JURISDICTION

- A. The "Authority Having Jurisdiction" (AHJ) over the project described by these documents is the City of San Antonio, Texas.
- B. Where alterations and/or deviations from the Contract Documents, i.e. Drawings and Specifications, are required by the AHJ, report the requirements to the Architect and secure his written approval before starting the alteration.
- C. Modifications to the Division 22 work required by the AHJ shall be made by the Contractor without additional cost to the Owner.

4.3 CODES AND REFERENCE STANDARDS

- A. All materials and workmanship shall comply with the requirements of the Building, Mechanical, Electrical, Plumbing, Fire, Accessibility, and Energy Codes adopted by the Authority Having Jurisdiction, including all amendments, applicable laws and ordinances and supplementary rules and interpretations. Where Contract Document requirements exceed Code requirements and are permitted under the Code, the Contract Documents shall govern.
- B. In all cases where Underwriter's Laboratories, Inc. have established standards for a particular type material, such material shall comply with these standards or other nationally recognized testing standards acceptable to the Authority Having Jurisdiction. Evidence of compliance shall be the UL "label" or "listing" under Re-Examination Service.
- C. The following specific codes and standards shall apply to this project:
 - 1. ADA Accessibility Guidelines for Buildings and Facilities, (ADAAG) with current amendments.
 - 2. Americans with Disabilities Act, Part III, 28 CFR 36, (ADA).
 - 3. Building Services Piping (ASME/ANSI B31.9).
 - 4. Elimination of Architectural Barriers Act, Texas Department of Licensing and Regulations, Texas Civil Statutes, Article 9102,
 - 5. Energy Conservation Standard for New State Buildings.
 - 6. Governing Fire Department requirements.
 - 7. National Fire Codes (NFPA), current edition.
 - 8. National Electrical Code (NFPA 70), latest edition.

9. Occupational Safety and Health Act (OSHA).
 10. Safety Code for Elevators and Escalators (ASME A17.1).
 11. Standards for Access to the Handicapped (ANSI 117.1).
 12. Texas Accessibility Standards (TAS), Texas Department of Licensing and Regulations (TDLR), Architectural Barriers Act, Article 9102, Texas Civil Statutes, effective April 1, 1994.
 13. Texas Boiler Law, Chapter 755, Health and Safety Code, Texas Department of Licensing and Regulations.
 14. International Building code with local amendments.
 15. International Mechanical code with local amendments.
 16. International Fire code with local amendments.
 17. International Energy conservation code with local amendments.
 18. International Plumbing code with local amendments.
 19. National Electric code with local amendments.
 20. Supplemental with local amendments.
- D. Refer to Division 01 and the Division 22 Specification Sections hereinafter bound for additional applicable regulatory requirements.

4.4 OWNER'S RULES AND REGULATIONS

- A. Comply with Owner's rules and regulations as they apply.

4.5 DISCREPANCIES

- A. 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 and the Engineer in writing of said discrepancies and apply for an interpretation.
- B. Should the discovery and notification occur after the execution of the Contract, any additional work required for compliance with said regulations shall be paid for as covered by applicable Division, providing no work or fabrication of materials has been accomplished in a manner of noncompliance.
- C. 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.

END OF SECTION

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Sleeves.
- 2. Stack-sleeve fittings.
- 3. Sleeve-seal systems.
- 4. Sleeve-seal fittings.
- 5. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

- A. 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. Smith, Jay R. Mfg. Co.

2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
 1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

- A. 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. Advance Products & Systems, Inc.
 2. CALPICO, Inc.
 3. Metraflex Company (The).
 4. Pipeline Seal and Insulator, Inc.
 5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 2. Pressure Plates: Carbon steel.
 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

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

2.5 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
 - 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6: Sleeve-seal fittings
 - b. Piping NPS 6 and Larger: Cast-iron wall sleeves
 - 2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping [NPS 6] <Insert pipe size> and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping [NPS 6] <Insert pipe size> and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 4. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: PVC-pipe sleeves
 - b. Piping NPS 6 and Larger: PVC-pipe sleeves
 - 5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: PVC-pipe sleeves
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves

END OF SECTION

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - g. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with rough-brass finish.
 - h. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
 - i. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with rough-brass finish.
 - j. Bare Piping in Equipment Rooms: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
 2. Escutcheons for Existing Piping:
 - a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
 - f. Bare Piping in Unfinished Service Spaces: Split-casting brass type with rough-brass finish.
 - g. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
 - h. Bare Piping in Equipment Rooms: Split-casting brass type with rough-brass finish.
 - i. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
1. New Piping: One-piece, floor-plate type.
 2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION

SECTION 220523 - GENERAL-DUTY VALVES for PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. Iron ball valves.
4. Bronze lift checks valves.
5. Bronze swing checks valves.
6. Iron swing check valves.
7. Iron swing check valves with closure control.
8. Iron, grooved-end swing checks valves.
9. Iron, center-guided check valves.
10. Iron, plate-type check valves.
11. Bronze gate valves.
12. Iron Gate valves.
13. Lubricated plug valves.

B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
3. Section 220500 "Common Work Results for Plumbing".

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: No rising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.

1.4 SUBMITTALS

- A. Product Data: For each type of valve utilized.

1.5 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 2. ASME B31.1 for power piping valves.
 3. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
 2. Protect threads, flange faces, grooves, and weld ends.
 3. Set angle and gate valves closed to prevent rattling.
 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 5. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use hand wheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
1. Hand wheel: For valves other than quarter-turn types.
 2. Hand lever: For quarter-turn valves NPS 6 and smaller except plug valves.

3. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug-valve head.
- E. Valves in Insulated Piping: With stem extensions and the following features:
 1. Gate Valves: With rising stem.
 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
- F. Valve-End Connections:
 1. Flanged: With flanges according to ASME B16.1 for iron valves.
 2. Grooved: With grooves according to AWWA C606.
 3. Solder Joint: With sockets according to ASME B16.18.
 4. Threaded: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

- A. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Jomar International, LTD.
 - b. Kitz Corporation.
 - c. Marwin Valve; a division of Richards Industries.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - e. Apollo.
 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Forged brass.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Full.

2.3 BRONZE BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. Hammond Valve.

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

2.4 BRONZE LIFT CHECK VALVES

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

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
- 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

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

- 1. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: NBR, PTFE, or TFE.

2.5 BRONZE SWING CHECK VALVES

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

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Valve, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.

- d. Crane Co.; Crane Valve Group; Stockham Division.
 - e. Hammond Valve.
 - f. Kitz Corporation.
 - g. Milwaukee Valve Company.
 - h. NIBCO INC.
 - i. Powell Valves.
 - j. Red-White Valve Corporation.
 - k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - l. Zy-Tech Global Industries, Inc.
2. Description:
- a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

2.6 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. NIBCO INC.
2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Gasket: Asbestos free.
 - h. Closure Control: Factory-installed, exterior lever and spring.

2.7 IRON, CENTER-GUIDED CHECK VALVES

A. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:

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. Anvil International, Inc.
 - b. APCO Willamette Valve and Primer Corporation.
 - c. Crispin Valve.
 - d. DFT Inc.
 - e. Flo Fab Inc.
 - f. GA Industries, Inc.
 - g. Hammond Valve.
 - h. Metraflex, Inc.

- i. Milwaukee Valve Company.
 - j. Mueller Steam Specialty; a division of SPX Corporation.
 - k. NIBCO INC.
 - l. Spence Strainers International; a division of CIRCOR International, Inc.
 - m. Sure Flow Equipment Inc.
 - n. Val-Matic Valve & Manufacturing Corp.
 - o. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
- a. Standard: MSS SP-125.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Compact wafer.
 - e. Seat: Bronze.

2.8 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:

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. American Valve, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Division.
 - e. Hammond Valve.
 - f. Kitz Corporation.
 - g. Milwaukee Valve Company.
 - h. NIBCO INC.
 - i. Powell Valves.
 - j. Red-White Valve Corporation.
 - k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - l. Zy-Tech Global Industries, Inc.
2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded r solder joint.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Hand heel: Malleable iron, bronze, or aluminum.

B. Class 125, RS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Valve, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.

- d. Crane Co.; Crane Valve Group; Stockham Division.
 - e. Hammond Valve.
 - f. Kitz Corporation.
 - g. Milwaukee Valve Company.
 - h. NIBCO INC.
 - i. Powell Valves.
 - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - k. Zy-Tech Global Industries, Inc.
2. Description:
- a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Hand wheel: Malleable iron, bronze, or aluminum.
- C. Class 150, NRS Bronze Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hammond Valve.
 - b. Kitz Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Powell Valves.
 - f. Red-White Valve Corporation.
 - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Hand wheel: Malleable iron, bronze, or aluminum.
- D. Class 150, RS Bronze Gate Valves:
1. Manufacturers: Subject to compliance with requirements, ,provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. Hammond Valve.
 - d. Kitz Corporation.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Powell Valves.

- h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- i. Zy-Tech Global Industries, Inc.
- 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Hand wheel: Malleable iron, bronze, or aluminum.

2.9 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:

- 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. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - d. Flo Fab Inc.
 - e. Hammond Valve.
 - f. Kitz Corporation.
 - g. Legend Valve.
 - h. Milwaukee Valve Company.
 - i. NIBCO INC.
 - j. Powell Valves.
 - k. Red-White Valve Corporation.
 - l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - m. Zy-Tech Global Industries, Inc.
- 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Disc: Solid wedge.
 - g. Packing and Gasket: Asbestos free.

B. Class 125, OS&Y, Iron Gate Valves:

- 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. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - d. Flo Fab Inc.
 - e. Hammond Valve.

- f. Kitz Corporation.
 - g. Legend Valve.
 - h. Milwaukee Valve Company.
 - i. NIBCO INC.
 - j. Powell Valves.
 - k. Red-White Valve Corporation.
 - l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - m. Zy-Tech Global Industries, Inc.
2. Description:
- a. Standard: MSS SP-70, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Disc: Solid wedge.
 - g. Packing and Gasket: Asbestos free.

2.10 LUBRICATED PLUG VALVES

A. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Nordstrom Valves, Inc.
2. Description:
 - a. Standard: MSS SP-78, Type II.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
 - d. Pattern: Regular or short Venturi.
 - e. Plug: Cast iron or bronze with sealant groove.

B. Class 125, Regular-Gland, Lubricated Plug Valves with Flanged Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Nordstrom Valves, Inc.
2. Description:
 - a. Standard: MSS SP-78, Type II.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
 - d. Pattern: Regular or short Venturi.
 - e. Plug: Cast iron or bronze with sealant groove.

C. Class 125, Cylindrical, Lubricated Plug Valves with Threaded Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Homestead Valve; a division of Olson Technologies, Inc.
 - b. Milliken Valve Company.
 - c. R & M Energy Systems; a unit of Robbins & Myers, Inc.
 2. Description:
 - a. Standard: MSS SP-78, Type IV.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
 - d. Pattern: Regular or short.
 - e. Plug: Cast iron or bronze with sealant groove.
- D. Class 125, Cylindrical, Lubricated Plug Valves with Flanged Ends:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Homestead Valve; a division of Olson Technologies, Inc.
 - b. Milliken Valve Company.
 - c. R & M Energy Systems; a unit of Robbins & Myers, Inc.
 2. Description:
 - a. Standard: MSS SP-78, Type IV.
 - b. CWP Rating: 200 psig. .
 - c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
 - d. Pattern: Regular or short Venturi.
 - e. Plug: Cast iron or bronze with sealant groove.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.

- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
 - 3. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, butterfly valves.
 - 2. Throttling Service: Ball Valves.
 - 3. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
 - b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2" and Smaller:
 - 1. Bronze and Brass Valves: Threaded ends.
 - 2. Bronze Angle Valves: Class 125, Class 150 bronze disc.
 - 3. Ball Valves: Two piece, full port, brass or bronze with stainless-steel trim.
 - 4. Bronze Swing Check Valves: Class 125 bronze discs.
 - 5. Bronze Gate Valves: Class 125 , NRS RS
 - 6. Bronze Globe Valves: Class 125 bronze disc.

- B. Pipe NPS 2-1/2 and Larger:
1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
 2. Iron Ball Valves: Class 150.
 3. Iron Swing Check Valves: Class 125 metal seats.
 4. Iron Swing Check Valves with Closure Control: Class 125, lever and spring.
 5. Iron, Grooved-End Swing Check Valves: 300 CWP.
 6. Iron, Center-Guided Check Valves: Class 125 compact-wafer, metal seat.
 7. Iron, Plate-Type Check Valves: Class 125 dual plate; metal seat.
 8. Iron Gate Valves: Class 125 NRS OS&Y.

END OF SECTION

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

B. Related Sections:

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

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 3. Design seismic-restraint hangers and supports for piping and equipment.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Fiberglass strut systems.
 - 4. Pipe stands.
 - 5. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of trapeze hangers.
 - 2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.7 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

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

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

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

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. Flex-Strut Inc.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut Corporation; Tyco International, Ltd.
 - g. Wesanco, Inc.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel
7. Metallic Coating: Hot-dipped galvanized
8. Paint Coating: Epoxy
9. Plastic Coating: PVC

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
 - a. Anvil International; a subsidiary of Mueller Water Products Inc.
 - b. Empire Industries, Inc.
 - c. ERICO International Corporation.
 - d. Haydon Corporation; H-Strut Division.
 - e. NIBCO INC.
 - f. PHD Manufacturing, Inc.
 - g. PHS Industries, Inc.
 - h. <Insert manufacturer's name>.
2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.

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

2.4 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following
 1. Carpenter & Paterson, Inc.
 2. Clement Support Services.
 3. ERICO International Corporation.
 4. National Pipe Hanger Corporation.
 5. PHS Industries, Inc.
 6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 7. Piping Technology & Products, Inc.
 8. Rilco Manufacturing Co., Inc.
 9. Value Engineered Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

- C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
 - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 2. Base: Stainless steel.
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:
 - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 2. Bases: One or more; plastic.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 PIPE POSITIONING SYSTEMS

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

2.8 EQUIPMENT SUPPORTS

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

2.9 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

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

- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.
- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.
- F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- G. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- H. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.
- I. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- J. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- K. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- L. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- M. Install lateral bracing with pipe hangers and supports to prevent swaying.
- N. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger

and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

- O. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- P. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- Q. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils .
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and fiberglass pipe hangers and fiberglass strut systems and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
 - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 - 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 - 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 - 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 - 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 - 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 - 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to

NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.
- S. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

SECTION 22 0533 - HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes plumbing piping heat tracing for freeze prevention, domestic hot-water-temperature maintenance, and snow and ice melting on roofs and in gutters and downspouts with the following electric heating cables:

- 1. Self-regulating, parallel resistance.

1.3 ACTION SUBMITTALS

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

- 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- 2. Schedule heating capacity, length of cable, spacing, thermostat, and electrical power requirement for each electric heating cable required.

- B. Shop Drawings: For electric heating cable and thermostat.

- 1. Include plans, elevations, sections, and attachment details.
- 2. Include diagrams for power, signal, and control wiring, show location of thermostat.
- 3. Include coordinated plans with plumbing and electrical connections.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

- B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

- 1. Warranty Period: 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers:

1. BriskHeat.
2. Chromalox.
3. Delta-Therm Corporation.
4. Pyrotenax; a brand of Tyco Thermal Controls LLC.
5. Raychem; a brand of Tyco Thermal Controls LLC.
6. Thermon Americas Inc.
7. Trasor Corp.

B. Comply with IEEE 515.1.

C. Heating Element: Pair of parallel No. 16 AWG, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

D. Electrical Insulating Jacket: Flame-retardant polyolefin.

E. Cable Cover: Tinned-copper braid and polyolefin outer jacket with ultraviolet inhibitor.

F. Maximum Operating Temperature (Power On): 150 deg F.

G. Maximum Exposure Temperature (Power Off): 185 deg F.

H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Capacities and Characteristics:

1. Maximum Heat Output: 10 W/ft.
2. Piping Diameter: Refer to plumbing plans for pipe size.
3. Number of Parallel Cables: 2.

2.2 CONTROLS

A. Pipe-Mounted Thermostats for Freeze Protection:

1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
4. Corrosion-resistant, waterproof control enclosure.

2.3 ACCESSORIES

- A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.
- B. Warning Tape: Continuously printed "Electrical Tracing"; Refer to section 220553 Identification for Plumbing Piping & Equipment.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Install the following types of electric heating cable for the applications described:
 - 1. Temperature Maintenance for Domestic Cold Water: Self-regulating, parallel-resistance heating cable.

3.3 INSTALLATION

- A. Electric Heating-Cable Installation for Freeze Protection for Piping:
 - 1. Install electric heating cables after piping has been tested and before insulation is installed.
 - 2. Install electric heating cables according to IEEE 515.1.
 - 3. Install insulation over piping with electric cables according to Section 220719 "Plumbing Piping Insulation."
 - 4. Install warning tape on piping insulation where piping is equipped with electric heating cables.
 - 5. Set field-adjustable switches and circuit-breaker trip ranges.

3.4 CONNECTIONS

- A. Ground equipment according to "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections:

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
 2. Test cables for electrical continuity and insulation integrity before energizing.
 3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
- C. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.
- D. Cables will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.6 PROTECTION

- A. Protect installed heating cables, including nonheating leads, from damage during construction.
- B. Remove and replace damaged heat-tracing cables.

END OF SECTION

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Minimum Label Size: Length and width vary for required label content, but not less than

- 2-1/2 by 3/4 inch.
 3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 4. Fasteners: Stainless-steel rivets or self-tapping screws.
 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 2. Letter Color: Black.
 3. Background Color: White.
 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.
- 2.2 WARNING SIGNS AND LABELS
- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.
 - B. Letter Color: Black.
 - C. Background Color: Yellow.
 - D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 - E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.4 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
 - 1. Stencil Material: Aluminum.
 - 2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link chain.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: 3 by 5-1/4 inches minimum.
 - 2. Fasteners: Reinforced grommet and wire or string.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09.
- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles, complying with ASME A13.1, on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

- D. Pipe Label Color Schedule:
 - 1. Domestic Water Piping:
 - a. Background Color: White.
 - b. Letter Color: Black.
 - 2. Sanitary Waste and Storm Drainage Piping:
 - a. Background Color: White.
 - b. Letter Color: Black.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:
 - a. Cold Water: 2 inches, square.
 - b. Hot Water: 2 inches, square.
 - c. Low-Pressure Compressed Air: 2 inches, square.
 - d. High-Pressure Compressed Air: 2 inches, square.
 - 2. Valve-Tag Color:
 - a. Cold Water: Natural.
 - b. Hot Water: Natural.
 - 3. Letter Color:
 - a. Cold Water: Black.
 - b. Hot Water: Black.

3.5 WARNING-TAG INSTALLATION

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

END OF SECTION

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic cold-water piping.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Comply with the following applicable standards and other requirements specified for

miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pittsburgh Corning Corporation; Foamglas.
 2. Block Insulation: ASTM C 552, Type I.
 3. Special-Shaped Insulation: ASTM C 552, Type III.
 4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 5. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
 6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA, Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Microlite.
 - b. Knauf Insulation; Friendly Feel Duct Wrap.
 - c. Owens Corning; SOFTR All-Service Duct Wrap.
- I. Mineral-Fiber, Preformed Pipe Insulation:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Armstrong
 - b. Knauf Insulation; 1000-Degree Pipe Insulation.
 - c. Owens Corning; Fiberglas Pipe Insulation.
 2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- J. Phenolic:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Kingspan Tarec Industrial Insulation NV; Koolphen K.
 - b. Resolco International BV; Insul-phen.
 2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
 3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
 4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
 5. Factory-Applied Jacket: ASJ. Requirements are specified in "Factory-Applied Jackets" Article.
- K. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Armacell LLC; Tubolit.
 - b. Nomaco Insulation; IMCOLOCK and NOMALOCK.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Ramco Insulation, Inc.; Super-Stik.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Ramco Insulation, Inc.; Thermokote V.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA, Inc.; Aeroseal.
 - b. Armacell LLC; Armaflex 520 Adhesive.
 - c. K-Flex USA; R-373 Contact Adhesive.
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- E. Phenolic Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
1. Products: Subject to compliance with requirements, provide one of the following:

- a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-96.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-33.
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- F. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.
 - d. Mon-Eco Industries, Inc.; 22-25.
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- G. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 739, Dow Silicone.
 - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Polyco VP Adhesive.
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
 - b. Vimasco Corporation; 749.
 - 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 - 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
 - b. Eagle Bridges - Marathon Industries; 550.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
 - d. Mon-Eco Industries, Inc.; 55-50.
 - e. Vimasco Corporation; WC-1/WC-5.
 - 2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: 60 percent by volume and 66 percent by weight.
 - 5. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
 - 1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Products: Subject to compliance with requirements, provide one of the following:

- a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
- b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
- c. Vimasco Corporation; 713 and 714.
3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.6 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass and Phenolic Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, a business of H. B. Fuller Company; CP-76.
 - b. Foster Brand, a business of H. B. Fuller Company; 30-45.
 - c. Pittsburgh Corning Corporation; Pittseal 444.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 200 deg F.
5. Color: White or gray.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, a business of H. B. Fuller Company; CP-76.
 - b. Foster Brand, a business of H. B. Fuller Company; 95-44.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, a business of H. B. Fuller Company; CP-76.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 5. Color: White.
 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, a business of H. B. Fuller Company; Chil-Glas Number 10.
- B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Foster Brand, a business of H. B. Fuller Company; Mast-A-Fab.
 - b. Vimasco Corporation; Elastafab 894.

2.9 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.10 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 - 2. Adhesive: As recommended by jacket material manufacturer.
 - 3. Color: White.
 - 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- C. Metal Jacket:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, a business of H. B. Fuller Company; Metal Jacketing Systems.
 - b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
 - c. RPR Products, Inc.; Insul-Mate.
 - 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.

- e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- 3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
 - a. Sheet and roll stock ready for shop or field sizing.
 - b. Material, finish, and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- D. Underground Direct-Buried Jacket: 125-mil- thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pittsburgh Corning Corporation; Pittwrap.
 - b. Polyguard Products, Inc.; Insulrap No Torch 125.

2.11 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 1. Products: Subject to compliance with requirements, provide one of the following:

- a. ABI, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - c. Compac Corporation; 104 and 105.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 491 AWF FSK.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - c. Compac Corporation; 110 and 111.
 - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
 2. Width: 3 inches.
 3. Thickness: 6.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lb/inch in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 370 White PVC tape.
 - b. Compac Corporation; 130.
 - c. Venture Tape; 1506 CW NS.
 2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inch in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lb/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 488 AWF.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.

- c. Compac Corporation; 120.
- d. Venture Tape; 3520 CW.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lb/inch in width.

2.12 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ITW Insulation Systems; Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping and Seals.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 1/2 inch wide with closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020-inch-thick, 1/2 inch wide with closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. Wire: 0.080-inch nickel-copper alloy.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C & F Wire.

2.13 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Engineered Brass Company.
 - b. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
 - c. McGuire Manufacturing.
 - d. Plumberex.
 - e. Truebro; a brand of IPS Corporation.
 - f. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Truebro; a brand of IPS Corporation.
 - b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches

- indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation

- of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 4. Install insulation to flanges as specified for flange insulation application.

3.9 INSTALLATION OF PHENOLIC INSULATION

- A. General Installation Requirements:
1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
 2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
- B. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

C. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.10 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.11 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.12 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew

proof.

- a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.13 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.14 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 1. Drainage piping located in crawl spaces.
 2. Underground piping.

3.15 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
 1. NPS 1 and Smaller: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

2. NPS 1-1/4 and Larger: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- B. Domestic Hot, Tempered and Recirculated Hot Water:
 1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1½" thick.
- C. Stormwater and Overflow:
 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- D. Roof Drain and Overflow Drain Bodies:
 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
- F. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:
 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Phenolic: 1 inch thick.

3.16 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 1. ASJ-SSL jacket.
- D. Piping, Exposed:
 1. ASJ-SSL jacket.

3.17 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Domestic water pipes, tubes, fittings, and specialties inside the building.
 - 2. Specialty valves.
 - 3. Flexible connectors.
 - 4. Escutcheons.
 - 5. Sleeves and sleeve seals.
 - 6. Wall penetration systems.

1.3 SUBMITTALS

- A. Product Data: For the following products:
 - 1. Specialty valves.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Flexible connectors.
 - 5. Backflow preventers and Vacuum breakers.
 - 6. Escutcheons.
 - 7. Sleeves and sleeve seals.
 - 8. Wall penetration systems.
 - 9. Piping.
- B. Water Samples: Specified in "Cleaning" Article.
- C. Refer to Section 220500 "Common Work Results for Plumbing".
- D. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic, potable domestic water piping and components.
- C. Comply with NSF 61 for potable domestic water piping and components.

1.5 COORDINATION

- A. Refer to Section 220500 "Common Work Results for Plumbing."

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 COPPER TUBE AND FITTINGS

- A. Below Grade:

- 1. Three-inch diameter and smaller: ASTM B 88 copper tubing, Type L, hard temper, with ASME B16.22 wrought copper fittings and brazed joints conforming to ASME A5.8 BCuP lead free brazing material and AWS A5.31 flux.
 - a. Design underground piping systems to accommodate expansion and contraction of piping using expansion and offset loops, without the use of slop couplings.

- B. Above Grade:

- 1. 2-1/2 inch diameter and smaller: ASTM B 88, Type L, hard drawn copper with ASME B16.18 cast bronze or ASME B16.22 wrought copper and bronze fittings and soldered joints using ASME B 32, Grade 95T solder and ASTM B 813 flux.
- 2. 2-1/2 inch to 4-inch diameter: ASTM B 88, Type L, hard drawn copper with ASME B16.18 cast bronze or ASME B16.22 wrought copper and bronze fittings and brazed joints using ASME A5.8 BCuP lead free brazing material and AWS A5.31 flux. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- 3. Piping larger than 4-inch diameter: ASTM A 53 galvanized steel pipe, schedule 40, cast iron fittings, galvanized, grooved mechanical coupling joints. Copper Pressure-Seal-Joint Fittings:

2.3 SPECIALTY VALVES

- A. Comply with requirements in Section 220523 "General-Duty Valves for Plumbing Piping" for general-duty metal valves.
- B. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.4 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
- B. Dielectric Unions:
 - 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. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. EPCO Sales, Inc.

- d. Hart Industries International, Inc.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - f. Zurn Plumbing Products Group; Wilkins Water Control Products.
 - 2. Description:
 - a. Pressure Rating: 150 psig.
 - b. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
- 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. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. EPCO Sales, Inc.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Factory-fabricated, bolted, companion-flange assembly.
 - b. Pressure Rating: 150 psig.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Kits:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Description:
 - a. Non-conducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.
- E. Dielectric Couplings:
- 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. Calpico, Inc.
 - b. Lochinvar Corporation.
 - 2. Description:
 - a. Galvanized-steel coupling.
 - b. Pressure Rating: 300 psig at 225 deg F.
 - c. End Connections: Female threaded.
 - d. Lining: Inert and non-corrosive, thermoplastic.
- F. Dielectric Nipples:

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. Perfection Corporation; a subsidiary of American Meter Company.
 - b. Precision Plumbing Products, Inc.
 - c. Victaulic Company.
2. Description:
 - a. Electroplated steel nipple complying with ASTM F 1545.
 - b. Pressure Rating: 300 psig at 225 deg F.
 - c. End Connections: Male threaded or grooved.
 - d. Lining: Inert and non
 - e. Corrosive, propylene.

2.5 FLEXIBLE CONNECTORS

- 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. Flex-Hose Co., Inc.
 2. Flexicraft Industries.
 3. Flex Pression, Ltd.
 4. Flex-Weld, Inc.
 5. Hyspan Precision Products, Inc.
 6. Mercer Rubber Co.
 7. Metraflex, Inc.
 8. Proco Products, Inc.
 9. Tozen Corporation.
 10. Unaflex, Inc.
 11. Universal Metal Hose; a Hyspan company
- B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 1. Working-Pressure Rating: Minimum 200 psig.
 2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
 3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.
- C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
 1. Working-Pressure Rating: Minimum 200 psig.
 2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
 3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.6 ESCUTCHEONS

- A. Refer to Section 220500 "Common Work Results for Plumbing".

2.7 SLEEVES

- A. Refer to Section 220500 "Common Work Results for Plumbing".

2.8 SLEEVE SEALS

- A. Refer to Section 220500 "Common Work Results for Plumbing".

2.9 WALL PENETRATION SYSTEMS

- 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. SIGMA.
 2. Link Seal.
- B. Description: Wall-sleeve assembly, consisting of housing and gland, gaskets, and pipe sleeve.
1. Carrier-Pipe Deflection: Up to 5 percent without leakage.
 2. Housing: Ductile-iron casting with hub, water stop, anchor ring, and locking devices. Include gland, bolts, and nuts.
 3. Housing-to-Sleeve Gasket: EPDM rubber.
 4. Housing-to-Carrier-Pipe Gasket: AWWA C111, EPDM rubber.
 5. Pipe Sleeve: AWWA C151, ductile-iron pipe.

2.10 GROUT

- A. Refer to Section 220500 "Common Work Results for Plumbing".

PART 3 -EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install shutoff valve, hose-end drain valve, strainer, pressure gauge(s), and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Section 220519 "Meters and Gauges for Plumbing Piping" for pressure gauge(s) and Section 221119 "Domestic Water Piping Specialties" for drain valves and strainers.
- E. Install shutoff valve immediately upstream of each dielectric fitting.
- F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for pressure-reducing valves.
- G. Install domestic water piping level and plumb.

- H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- J. 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.
- K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- L. Install piping adjacent to equipment and specialties to allow service and maintenance.
- M. Install piping to permit valve servicing.
- N. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- O. Install piping free of sags and bends.
- P. Install fittings for changes in direction and branch connections.
- Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- R. Install pressure gauges on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Section 220519 "Meters and Gauges for Plumbing Piping" for pressure gauges.
- S. Install thermometers on outlet piping from each water heater. Comply with requirements in Section 220519 "Meters and Gauges for Plumbing Piping" for thermometers.

3.2 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

- E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

3.3 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Section 220523 "General-Duty Valves for Plumbing Piping" for valve installations.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Section 221119 "Domestic Water Piping Specialties."
 - 1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
 - 2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
- D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 and smaller and butterfly valves for piping NPS 2-1/2 and larger. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for balancing valves.

3.4 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 "

- D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 2. NPS 1 and NPS 1-1/4 72 inches with 3/8-inch rod.
 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 5. NPS 3 to NPS 5 10 feet with 1/2-inch rod.
 6. NPS 6: 10 feet with 5/8-inch rod.
 7. NPS 8 D: 10 feet 3 m with 3/4-inch 19-mm rod.
- E. Install supports for vertical copper tubing every 10 feet 3 m.
- F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2 DN 50: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2 DN 65: 11 feet 3.4 m with 1/2-inch 13-mm rod.
 5. NPS 3 and NPS 3-1/2 DN 80 and DN 90: 12 feet 3.7 m with 1/2-inch 13-mm rod.
 6. NPS 4 and NPS 5 DN 100 and DN 125: 12 feet 3.7 m with 5/8-inch 16-mm rod.
 7. NPS 6 DN 150: 12 feet 3.7 m with 3/4-inch 19-mm rod.
- G. Install supports for vertical steel piping every 15 feet

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to existing water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
 4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.7 ESCUTCHEON INSTALLATION

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

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

3.8 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves are not required for core-drilled holes.
- C. Permanent sleeves are not required for holes formed by removable PE sleeves.
- D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- E. Install sleeves in new partitions, slabs, and walls as they are built.
- F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealers" for joint sealants, and Section 220500 "Common Work Results for Plumbing."
- G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealers" for joint sealants, and Section 220500 "Common Work Results for Plumbing."
- H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals specified in this Section.
- I. Seal space outside of sleeves in concrete slabs and walls with grout.
- J. Install sleeves that are large enough to provide 1/4 annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.
- K. Install sleeve materials according to the following applications:
1. Sleeves for Piping Passing through Concrete Floor Slabs: Molded PVC or Steel pipe.
 2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe.
 - a. Extend sleeves 2" above finished floor level.
 - b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is

specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2" above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

3. Sleeves for Piping Passing through Gypsum-Board Partitions:
 - a. Steel pipe sleeves for pipes smaller than NPS 6.
 - b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.
 - c. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
 4. Sleeves for Piping Passing through Concrete Roof Slabs: Molded PVC or Steel pipe.
 5. Sleeves for Piping Passing through Exterior Concrete Walls:
 - a. Steel pipe for pipes smaller than NPS 6
 - b. Cast-iron wall pipe sleeves for pipes NPS 6 and larger.
 - c. Install sleeves that are large enough to provide 1- "annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
 - d. Do not use sleeves when wall penetration systems are used.
 6. Sleeves for Piping Passing through Interior Concrete Walls:
 - a. PVC pipe sleeves for pipes smaller than NPS 6.
 - b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.
- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Comply with requirements in Division 07 Section "Firestopping" for fire stop materials and installations, as well as Section 220500 "Common Work Results for Plumbing".

3.9 SLEEVE SEAL INSTALLATION

- A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
- B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.10 WALL PENETRATION SYSTEM INSTALLATION

- A. Install wall penetration systems in new, exterior concrete walls.
- B. Assemble wall penetration system components with sleeve pipe. Install so that end of sleeve pipe and face of housing are flush with wall. Adjust locking devices to secure sleeve pipe in housing.

3.11 IDENTIFICATION

- A. Identify system components. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- B. Label pressure piping with system operating pressure.

3.12 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

- B. Piping Inspections:
1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 3. Re inspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for re inspection.
 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests:
1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 6. Prepare reports for tests and for corrective action required.
- D. Domestic water piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.13 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Open throttling valves to proper setting.
 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.

7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.14 CLEANING

- A. Clean and disinfect potable and non-potable domestic water piping as follows:
 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Clean non-potable domestic water piping as follows:
 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.15 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building service piping, NPS 1-1/2" and smaller, shall be one of the following:

1. Soft copper tube, ASTM B 88, Type K wrought-copper solder-joint fittings; and brazed joints.
- E. Under-building-slab, domestic water, building-service piping, NPS 2 to NPS 8 and larger, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.
 2. Mechanical-joint, ductile-iron pipe; standard- or compact- pattern mechanical-joint fittings; and mechanical joints.
 3. Push-on-joint, ductile-iron pipe; standard- or compact- pattern push-on-joint fittings; and gasketed joints.
- F. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type cast- or wrought- copper solder-joint fittings; and soldered joints.
 2. Hard copper tube, ASTM B 88, Type L copper pressure-seal-joint fittings; and pressure-sealed joints.
- G. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L cast or wrought- copper solder-joint fittings; and brazed joints.

3.16 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
 3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
 4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.

1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For sovent drainage system. Include plans, elevations, sections, and details.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

1.7 PROJECT CONDITIONS

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

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.
- C. Heavy-Duty, Hubless-Piping Couplings:
1. Manufacturers:
 - a. ANACO-Husky.
 - b. Clamp-All Corp.
 - c. Dallas Specialty & Mfg. Co.
 - d. MIFAB, Inc.
 - e. Mission Rubber Company; a division of MCP Industries, Inc.
 - f. Stant.
 - g. Tyler Pipe.
 2. Standards: ASTM C 1277 and ASTM C 1540.
 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
- D. Cast-Iron, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MG Piping Products Company.
 2. Standard: ASTM C 1277.
 3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- C. Adhesive Primer: ASTM F 656.
1. One or both subparagraphs below may be required to comply with Project requirements or authorities having jurisdiction. Retain first subparagraph below if required for LEED-NC, LEED-CI, or LEED-CS Credit IEQ 4.1.
 2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Retain subparagraph below if required for LEED for Schools.
 4. Adhesive primer shall comply with the testing and product requirements of the Califor-

nia Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

- D. Solvent Cement: ASTM D 2564.
 - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

- 1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
- 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- 3. Unshielded, Non-pressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Dallas Specialty & Mfg. Co.
 - 2) Fernco Inc.
 - 3) Mission Rubber Company; a division of MCP Industries, Inc.
 - 4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- 4. Shielded, Non-pressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Mission Rubber Company; a division of MCP Industries, Inc.
 - b. Standard: ASTM C 1460.
 - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Dielectric Fittings:

- 1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- 2. Dielectric Unions:
 - a. Manufacturers: Subject to compliance with requirements, provide products by

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- one of the following:
- 1) Capitol Manufacturing Company.
 - 2) Central Plastics Company.
 - 3) Hart Industries International, Inc.
 - 4) Jomar International Ltd.
 - 5) Matco-Norca, Inc.
 - 6) McDonald, A. Y. Mfg. Co.
 - 7) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 8) Wilkins; a Zurn company.
- b. Description:
- 1) Standard: ASSE 1079.
 - 2) Pressure Rating: 150 psig.
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
3. Dielectric Flanges:
- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1) Capitol Manufacturing Company.
 - 2) Central Plastics Company.
 - 3) Matco-Norca, Inc.
 - 4) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 5) Wilkins; a Zurn company.
- b. Description:
- 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Pressure Rating: 150 psig.
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
4. Dielectric-Flange Insulating Kits:
- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1) Advance Products & Systems, Inc.
 - 2) Calpico, Inc.
 - 3) Central Plastics Company.
 - 4) Pipeline Seal and Insulator, Inc.
- b. Description:
- 1) Non-conducting materials for field assembly of companion flanges.
 - 2) Pressure Rating: 150 psig.
 - 3) Gasket: Neoprene or phenolic.
 - 4) Bolt Sleeves: Phenolic or polyethylene.
 - 5) Washers: Phenolic with steel backing washers.
5. Dielectric Nipples:
- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1) Elster Perfection.
 - 2) Grinnell Mechanical Products.
 - 3) Matco-Norca, Inc.
 - 4) Precision Plumbing Products, Inc.
 - 5) Victaulic Company.
- b. Description:
- 1) Standard: IAPMO PS 66
 - 2) Electroplated steel nipple.
 - 3) Pressure Rating: 300 psig.

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- 4) End Connections: Male threaded or grooved.
 - 5) Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 310000 "Site Earthwork."

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 2 percent downward in direction of flow for piping NPS 4 and larger.
 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- N. Install steel piping according to applicable plumbing code.
- O. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.
- P. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- Q. Install aboveground ABS piping according to ASTM D 2661.
- R. Install aboveground PVC piping according to ASTM D 2665.
- S. Install underground PVC piping according to ASTM D 2321.
- T. Install engineered soil and waste drainage and vent piping systems as follows:
1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 2. Sovent Drainage System: Comply with ASSE 1043 and sovent fitting manufacturer's written installation instructions.
 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- U. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.
- V. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.
- W. Install force mains at elevations indicated.
- X. Plumbing Specialties:
1. Install backwater valves in sanitary waster gravity-flow piping. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."
 2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
 3. Install drains in sanitary drainage gravity-flow piping.

- Y. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- Z. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
- C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- E. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.
- F. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- G. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
- H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- I. Plastic, Non-Pressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 - 3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in OD's.

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2. In Drainage Piping: Shielded, non-pressure transition couplings.
 3. In Aboveground Force Main Piping: Fitting-type transition couplings.
 4. In Underground Force Main Piping:
 - a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
 - b. NPS 2 and Larger: Pressure transition couplings.
- B. Dielectric Fittings:
1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
 3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
 4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 2. Install fiberglass pipe hangers for horizontal piping in corrosive environments.
 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 6. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 2. NPS 3: 60 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
 5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
 6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.

- H. Install supports for vertical PVC piping every 48 inches.
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 5. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Connect force-main piping to the following:
1. Sanitary Sewer: To exterior force main.
 2. Sewage Pump: To sewage pump discharge.
- E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- F. Make connections according to the following unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 - 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 6. Prepare reports for tests and required corrective action.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 4. Prepare reports for tests and required corrective action.

3.9 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.10 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
 - 1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
- C. Aboveground, vent piping NPS 4 and smaller shall be any of the following:
 - 1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
 - a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.
- D. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
 - 1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

END OF SECTION

SECTION 223300 - ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Flow-control, electric, tankless, domestic-water heaters.
 - 2. Thermostat-control, electric, tankless, domestic-water heaters.
 - 3. Domestic-water heater accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. LEED Submittals:
 - 1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1, Section 7, "Service Water Heating."
- C. Shop Drawings:
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For commercial domestic-water heaters, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Product Certificates: For each type of tankless, electric, domestic-water heater, from manufacturer.
- C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- D. Source quality-control reports.
- E. Field quality-control reports.

F. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.7 COORDINATION

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

1.8 WARRANTY

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

1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Periods: From date of Substantial Completion.
 - a. Electric, Tankless, Domestic-Water Heaters: Oneyear.

PART 2 - PRODUCTS

2.1 ELECTRIC, TANKLESS, domestic-WATER HEATERS

A. Flow-Control, Electric, Tankless, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings; or comparable product by one of the following:
 - a. Bosch Water Heating.
 - b. Chronomite Laboratories, Inc.
 - c. Eemax, Inc.
 - d. Stiebel Eltron, Inc.

3. Standard: UL 499 for electric, tankless, (domestic-water heater) heating appliance.
 4. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
 - a. Connections: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig (1035 kPa)
 - c. Heating Element: Resistance heating system.
 - d. Temperature Control: Electronic
 - e. Safety Control: High-temperature-limit cutoff device or system.
 - f. Jacket: Aluminum or steel with enameled finish or plastic.
 5. Support: Bracket for wall mounting.
 6. Capacity and Characteristics:
 - a. Flow Rate: 0.21 gpm
 - b. Maximum Temperature Setting: 100 F
 - c. Power Demand: 1.8 kw
 - d. Electrical Characteristics:
 - 1) Volts: 120
 - 2) Phases: Single.
 - 3) Hertz: 60.
 - 4) Full-Load Amperes: 15
 - 5) Minimum Circuit Ampacity: 15
 - 6) Maximum Overcurrent Protection: 15
- B. Thermostat-Control, Electric, Tankless, Domestic-Water Heaters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Bosch Water Heating.
 - b. Chronomite Laboratories, Inc.
 - c. Eemax, Inc.
 - d. Stiebel Eltron, Inc.
 3. Standard: UL 499 for electric, tankless, (domestic-water heater) heating appliance.
 4. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
 - a. Connections: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig (1035 kPa)
 - c. Heating Element: Resistance heating system.
 - d. Temperature Control: Electronic
 - e. Safety Control: High-temperature-limit cutoff device or system.
 - f. Jacket: Aluminum or steel with enameled finish or plastic.
 5. Support: Bracket for wall mounting.
 6. Capacity and Characteristics:
 - a. Flow Rate: 0.21 gpm
 - b. Temperature Setting: 90 deg F
 - c. Power Demand: 1.8 kw
 - d. Electrical Characteristics:
 - 1) Volts: 120
 - 2) Phases: Single.
 - 3) Hertz: 60.
 - 4) Full-Load Amperes: 15
 - 5) Minimum Circuit Ampacity: 15

6) Maximum Overcurrent Protection: 15

2.2 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and re-inspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Electric, Tankless, Domestic-Water Heater Mounting: Install electric, tankless, domestic-water heaters at least 18 inches (457 mm) above floor in valve box.
 - 1. Maintain manufacturer's recommended clearances.
 - 2. Arrange units so controls and devices that require servicing are accessible.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- B. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
 - 1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters Comply with requirements for shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
- C. Fill electric, domestic-water heaters with water.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
- C. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain tankless, electric, domestic-water heaters.

END OF SECTION

SECTION 224100 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted plumbing fixtures.
- B. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For plumbing fixtures and faucets to include in emergency, operation, and operation and maintenance manuals.
 - 1. In addition to items specified in Section 017000 "Execution and Closeout Requirements," include the following:

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.
 - 1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 - 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
 - 3. Flushometer-Tank Repair Kits: Equal to 5 percent of amount of each type installed, but no fewer than two of each type.
 - 4. Toilet Seats: Equal to 5 percent of amount of each type installed.

PART 2 - PRODUCTS (SEE DRAWINGS FOR FIXTURES AND TRIM SPECIFICATIONS)

2.1 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

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

- B. Examine walls, floors, cabinets, and counters for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install plumbing fixtures level and plumb according to roughing-in drawings.
- B. Install per ADA/TAS requirements where applicable. Coordinate flush valves with grab bar locations.
- C. Install floor-mounted water closets on closet flange attachments to drainage piping.
- D. Install counter-mounting fixtures in and attached to casework.
- E. Install pedestal lavatories on pedestals and secured to wood blocking in wall.
- F. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 - 1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Comply with valve requirements specified in Section 220523 "General-Duty Valves for Plumbing Piping."
- G. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.
- H. Install toilet seats on water closets.
- I. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- J. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- K. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes unless otherwise indicated.
- L. Install disposer in outlet of each sink indicated to have a disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
- M. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Install. Connect inlet hose to dishwasher and outlet hose to disposer.
- N. Install hot-water dispensers in back top surface of sink or in countertop with spout over sink.
- O. Set shower receptors in leveling bed of cement grout.
- P. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories and sinks. Comply with requirements in Section 220700 "Plumbing Insulation."
- Q. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220510 "Basic Requirements for Plumbing."
- R. Seal joints between plumbing fixtures, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealers."

3.4 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories and sinks. Comply with requirements in Section 220700 "Plumbing Insulation."

3.5 ADJUSTING

- A. Operate and adjust plumbing fixtures and controls, including but not limited to sensor operators. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.6 CLEANING AND PROTECTION

- A. After completing installation of plumbing fixtures, inspect and repair damaged finishes.
- B. Clean plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed plumbing fixtures and fittings.
- D. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

DIVISION 23

Heating Ventilating and Air Conditioning

95% Construction Documents

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Mechanical sleeve seals.
 - 5. Sleeves.
 - 6. Escutcheons.
 - 7. Grout.
 - 8. HVAC demolition.
 - 9. Equipment installation requirements common to equipment sections.
 - 10. Painting and finishing.
 - 11. Concrete bases.
 - 12. Supports and anchorages.
 - 13. Pre-demolition airflow measurements at all existing air handlers that are modified or replaced under this contract.
 - 14. Removal/replacement of ceilings to accomplish work depicted. Repair/replace any damage to existing finishes to the satisfaction of the Architect.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SUBMITTALS

- A. Product Data: For the following:

1. Transition fittings.
 2. Dielectric fittings.
 3. Mechanical sleeve seals.
 4. Escutcheons.
 5. All new or modified equipment, air handlers, etc.
 6. Ductwork.
 7. Hydronic Piping.
 8. Balancing devices.
 9. VAV terminals.
 10. Fire or Fire Smoke Dampers.
 11. Fans.
 12. Water coils.
 13. Smoke detector.
 14. Condensate drain piping material.
 14. As required by other Sections.
- B. Welding certificates.
- C. Coordinated Shop Drawing; contractor shall submit at minimum shop drawings that are coordinated with Electrical conduits locations, Fire protection Sprinkler System, IT cables and tray, Condensate Drain routing and termination, HVAC equipment, Ducts, VAV terminal units, All Access Panels, Plumbing piping and Valves, Chilled and Hot Water Piping and Structural elements, also refer to section 1.6.
- D. Location of installed Smoke Detectors where required by International Mechanical Code and Authority having Jurisdictions.
- 1.5 CONTRACTOR REQUIREMENTS
- A. The Contractor shall be currently licensed by all appropriate federal, state, county and municipal agencies to furnish and install the type of work set forth in the Contract Documents and the limits of the Contractor's license shall be adequate to accommodate the size of the contract.
- B. Within the scope of this project the Contractor and all of the Contractor's subcontractors shall apply for and obtain all necessary federal, state, county and municipal permits, fees and inspections. Include the costs of all fees, inspections and permits within the Contractor's bid price. Provide copies of any or all permits to the Owner upon request.
- 1.6 COORDINATION
- A. General: Refer to Division 1 for general coordination requirements applicable to the entire work. It is recognized that the Contract Documents are diagrammatic in showing certain physical relationships which must be established within the Mechanical work, and in its interface with other work including utilities and electrical 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. All major feeders 1-1/2" diameter and over shall be shown on site and floor plans.

- B. Arrange mechanical and electrical work in a neat, plumb and straight well organized and workmanlike manner with services running parallel with primary lines of the building construction and with a minimum of all manufacturer requirements and 12" above ceiling.
- C. 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 there to 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.
- D. 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 coordinated Shop Drawing for any change in equipment placement, etc.
- E. 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 with approval from Author by having jurisdiction
- F. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations. Do not cut any building surfaces, structural, etc., without written approval from the Architect.
- G. Coordinate installation of required supporting devices.
- H. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Openings."
- I. Coordinated Shop Drawing; contractor shall submit at minimum shop drawings that are coordinated with Electrical conduits locations, Fire protection Sprinkler System, IT cables and tray, Condensate Drain routing and termination, HVAC equipment, Ducts, VAV terminal units, All Access Panels, Plumbing piping and Valves, Chilled and Hot Water Piping and Structural elements.
- J. Contractor shall provide access panels that are 36"x36" at minimum in hard ceilings under equipment that require access by the code and equipment manufacturers. Access panels size shall be coordinated with engineer and architect prior to installation.
- K. All equipments, all wiring, insulations material, ductwork located in plenum spaces shall be plenum rated and comply with current codes.
- L. In existing structures contractor to verify that insulation above the ceiling are plenum rated if space is used as a plenum for return air conditioning.

- M. The Drawings show diagrammatic locations of the various outlets, air devices, ductwork, plumbing piping, apparatus and equipment. Exact locations of these outlets, air devices, ductwork 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 or equipment before installation, without additional cost to the Owner.
- N. 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 specifications are competent to fully explain, may not be mentioned on the Drawings
- O. 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.
- P. Coordination Drawings:
1. The Contractor shall prepare coordination computer aided drawings (CAD) of the installation of the mechanical (HVAC, plumbing and fire protection work using AutoCAD 2004 software, or later edition. Prepare drawings at a minimum scale of $1/8" = 1'-0"$, or at $1/4" = 1'-0"$ or at $1/2" = 1'-0"$ if necessary to provide the detail necessary to clearly show all of the work.
 2. The Contractor can obtain Electronic copies as outlined in the Record Drawings Section hereinafter.
 3. Coordination CAD drawings shall include the areas specified below and for a distance of fifty feet beyond in all directions. Provide coordination CAD drawings for:
 - a. All Air Handling Unit Rooms
 - b. All floor to floor piping or HVAC ductwork risers for the full length of the risers
 - c. All housekeeping concrete pads showing pad thickness, reinforcing, doweling
 4. The coordination CAD drawings shall show:
 - a. Plan view and at least two (2) section through all mechanical equipment rooms and areas listed above.
 - b. Architectural features.
 - c. Column lines.
 - d. Text shall be minimum height of $1/8"$ when plotted at full scale.
 - e. Provide graphic scales – do NOT use stated scales.
 - f. Provide separate layer(s) and/or "Xrefs" for each discipline (mechanical HVAC, plumbing, electrical, fire protection sprinkler, etc).
 - g. Room name, room number and NORTH ARROW
 - h. Mechanical equipment and equipment service/maintenance access areas
 - i. Provide elevation of each piece of equipment in each mechanical room, air handling unit room, roof, etc.
 - j. Piping shall be drawn two (2) line.
 - k. Ductwork shall be drawn two (2) line.
 - l. Electrical work (electrical equipment such as panels, transformers, etc. as well as conduit greater than 1" in size) and required clearances
 - m. Fire protection sprinkler work.
 5. The Contractor shall maintain these coordination CAD drawings throughout the course of the project making edits/updates to the drawings as necessary to accurately depict the installation of the work.

6. The Contractor may submit these drawings in accordance with the Record Drawings Section hereinafter.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.3 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.

- C. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150-psig steam working pressure minimum working pressure as required to suit system pressures.
- D. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F .
- E. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F .

2.4 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve. Fire rated mechanical sleeve sealing systems shall have the Factory Mutual Fire Approval. Mechanical sleeve sealing systems shall be designed for use as a permanent seal with seal emements compounded to resist aging, ozone, sunlight, water and a wide range of chemicals. Mechanical sleeve sealing systems shall allow for some angular and off center pipe conditions and still seal effectively.
 - 1. Sealing Elements for Normal Applications: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Sealing Elements for Fire Seal (Fire Rated) Applications: Silicone (Grey) interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Molded glass reinforced Nylon Polymer for normal applications. For fire and Hi-Temp service, pressure plates shall be steel with 2-part Zinc Dichromate Coating. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.
- B. Refer to paragraph 3.11 "FIRE STOP SYSTEMS".

2.5 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.

2.6 ESCUTCHEONS

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

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

2.7 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi , 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS – COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at required slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.

- c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - g. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
- M. Install sleeves for pipes passing through walls and concrete floor and roof slabs.
- N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs in finished service spaces.
- 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6 .
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - d. Seal space outside of sleeve fittings with grout.
 - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Also comply, as specified herein.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 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. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

- C. Install HVAC equipment to provide adequate space per manufacture requierments as minmum and access to maintain and service equipment and to facilitate service, maintenance, and repair or replacement of components. Install equipment with adequate space and access to comply with code requirements and to comply with manufacturer's installation instructions. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.
- E. New, as well as, refurbished equipment must be disassembled in order to pass through existing building openings; refer to notations on the drawings. If removal of existing glazing, door frames, walls, etc., is required, this shall be executed only after written approval is obtained from the Architect.

3.5 USE OF NEW SYSTEMS DURING CONSTRUCTION

- A. The Contractor is NOT allowed to use the new or refurbished HVAC system or any portion or part of the HVAC system during the construction phase of the project without the expressed written permission of the Owner.
- B. If the Owner should allow the Contractor to use the HVAC system during the construction phase of the project the Contractor shall furnish and install the following provisions:
 - 1. Furnish and install high efficiency (60 to 65% efficient), rigid, mini-pleated filters in all air handling units (AHUs). Replace filters with new clean filters at maximum one (1) month intervals.
 - 2. Furnish and install minimum 1-1/2" thick, flexible filter media over ALL return air openings (including ceiling return air grilles, etc.) and change at one (1) month intervals.
 - 3. If the Owner does allow the Contractor to use the HVAC system during the construction phase and if the Contractor does use the HVAC system during the construction phase then at the end of the use period by the Contractor the Contractor shall clean all coils in all operated AHUs. This shall mean that the Contractor steam clean and/or chemically clean all coils and all condensate drain pans in all operated AHUs. At the end of the use period by the Contractor during the construction phase the Contractor shall furnish and install a complete new set of filters in each operated AHU when the system is turned over to the Owner. It is the intent of this specification to provide the Owner with a new HVAC system that is as clean as is reasonably possible.

3.6 PAINTING

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

3.7 CONCRETE BASES (HOUSEKEEPING PADS)

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions.
 - 1. Construct concrete bases of dimensions required to extend a minimum 6" on all sides of the supported unit.
 - 2. Install dowel rods to connect concrete base to existing concrete floor. Unless otherwise indicated, install dowel rods on 12-inch centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 4000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Concrete".
8. Modify, remove, replace existing pads to comply with new equipment/layouts. Where existing pads are removed, grind down to a smooth finish to match the surrounding existing concrete floor. All pads existing outside of new/refurbished equipment dimensions +6" each way are to be removed.

3.8 INSTALLATION

- A. All equipment shall be installed in a manner to permit access to parts requiring service without disassembly of piping mains and other equipment. Access panels or doors shall be coordinated with the Architect and provided where necessary to permit valve equipment service or removal. Refer to the architectural specifications for additional requirements.
- B. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to permit access through stairways, doorways, or shafts shall be brought to the job disassembled, and re-assembled inside the Mechanical Rooms. Following placement in the space, such apparatus shall be thoroughly and completely protected against damage.
- C. Minimize installation of water piping in proximity of rooms housing telephone equipment, fire alarm systems, transformers, or other electrical equipment. Do not install water piping within, or above ceilings of these rooms.

3.9 CUTTING AND PATCHING

- A. Where it becomes necessary to cut through any wall, floor, or ceiling to permit installation of any work under this section of the Specifications or to repair any defects that may appear, up to the expiration of the guarantee period, such cutting shall be done under the supervision of the Architect by the Contractor. The Contractor shall not be permitted to cut or modify any building surfaces, slabs, etc., without the written permission of the Architect.
- B. Patching of all openings cut by the Contractor, or repairing of any damage to the work of other trades occasioned by cutting operations, or occasioned by the failure of any part of work installed under this contract, shall be performed by the trade whose work is involved, but shall be paid for by the Contractor.
- C. Any openings cut through exterior walls or roofs shall be provided with suitable covers, while they are left open, to protect the property or materials involved and maintain security.

3.10 FIRE STOP SYSTEMS

- A. Seal all pipe, conduit, cables, spare sleeves, etc. penetrations through roofs and fire-rated walls and floors with factory made devices or with manufactured fill, void, or cavity materials classified by

Underwriters Laboratories (UL) as a "through-penetration fire stop" and which meet the following requirements:

1. Maintain the fire resistance rating of the penetrated building construction. Refer to the architectural Contract Documents for fire ratings of general construction.
 2. Comply with the requirements of ASTM E814, UL 1979, ASTM E119, UL 723, ASTM E84 and UL 263 for all types of penetrations sealed.
 3. Do not exhibit excessive shrinkage, which would permit transmission of flame, smoke, gasses, vermin and/or water prior to exposure to a fire condition.
 4. Mastics used to seal surface of fire stop system shall be non-hardening.
 5. Shall accommodate expansion and contraction of the penetrating element, i.e. pipe etc., without reducing its effectiveness as a smoke barrier and/or water seal.
- B. Submittal data for fire stop systems shall include applicable UL System numbers.
- C. Installing Contractor shall submit evidence that he has been trained by an authorized fire stop system manufacturer's representative prior to beginning the installation. The manufacturer's representative shall visit the jobsite and visually observe representative samples of each of the various fire stop systems employed on this project, during and after installation, and provide a written certification that the installations observed appear to have been installed in accordance with the manufacturer's recommendations and UL requirements.
- D. Sealing of conduits that extend through fire-rated walls from ends of cable tray shall be performed after conductors/cables have been installed.
- E. Acceptable Manufacturer's Products: If it complies with these Specifications, one of the following manufacturers' fire stop sealing components/systems will be acceptable:
1. 3M Fire Protection Products.
 2. General Electric and Specified Technologies, Inc. SpecSeal systems.
 3. Nelson Flameseal Fire Stop Putty (dry locations only).
 4. Specified Technologies, Inc.
 5. Tremco Fire Resistive Joint System utilizing "Dymeric" sealant and Cerablanket-FS mineral filler.

3.11 HOISTING, SCAFFOLDING, AND TRANSPORTATION

- A. The Contractor shall provide his own hoisting facilities and scaffolding to set his materials and equipment in place, as indicated on Drawings and for subsequent cleaning, testing, and adjusting.
- B. The Contractor shall provide necessary transportation to facilitate the delivery of all materials, equipment, tools, and labor to the job, in accordance with intent of these documents.

3.12 CLEANING

- A. The Contractor shall, at all times, keep the premises free from accumulations of waste material or rubbish caused by him, his employees, or his work. This debris shall be removed, not only from the building, but also from the project site.
- B. At completion of the job, the Contractor shall remove all of his tools, scaffolding, and surplus materials. He shall leave the area "broom clean".

3.13 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT

- A. Unless specifically shown, indicated, or specified to the contrary, each item shown or required by the Mechanical Drawings or specified in the Mechanical Specifications shall be accompanied by all motors and starting and controlling equipment necessary for the items proper operations. These motors shall be integrally attached to and/or installed with their associated equipment item and electrically connected as specified in Division 26 - Electrical. Equipment controlled from motor control centers shall be supplied with motors only. Motor control centers are specified in Division 26 and shown on the Electrical Drawings.

3.14 WORK IN EXISTING BUILDINGS

- A. The work to be performed on this project occurs within an existing occupied building. Noisy, dusty, fume emitting and/or other construction operations required for work which may disturb Airport operations are unacceptable.
- B. The Contractor and the Division 23 Subcontractor shall carefully examine the existing building and review all of the Contract Documents prior to submitting his bid in order to determine the extent of work required to be completed under this Division. Failure to conduct this examination shall not relieve the Contractor of the responsibility to perform all the work required for a complete and fully operational installation satisfactory to the Owner.
- C. Contractor shall include in the bid price cost of relocation or removal of existing equipment and systems required for complete installation of the new systems indicated in the Contract Documents. In submitting his bid, the Contractor agrees to accept all existing site conditions not specifically accepted. Where Contract Documents conflict with existing field conditions, a record of the field conditions shall be provided in writing to the Architect.
- D. 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 service 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.
- E. All new work shall be coordinated with existing space constraints. All equipment and material shall be fabricated such that complete systems may be disassembled into sections suitable for lifting in the existing freight elevator or construction hoist and fit through existing passageways without unauthorized modifications of the existing building construction.
- F. The Contractor shall provide temporary 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.
- G. 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.
- H. Coordinate new work in existing building in a manner that allows proper phasing of the work without disruption of Owner's activities in occupied spaces. All work scheduled in occupied areas

MUST BE COORDINATED WITH AND APPROVED BY THE OWNER prior to commencement of the work.

- I. The Contractor shall use construction methods and materials which shall not adversely affect the indoor air quality of the occupied areas. Contractor shall furnish and install temporary constructions and modify existing air handling system where required to isolate areas under construction from surrounding occupied areas to control the migration of dust or fumes. If deemed necessary by the Owner, the Contractor shall furnish and install temporary supply and/or exhaust fan to negatively pressurize the construction area relative to adjacent occupied areas.

3.17 COMMUNICATIONS AND ELECTRICAL EQUIPMENT ROOMS PRECAUTIONS

- A. In general, piping shall not be installed in any switchgear, transformer, elevator equipment, telephone, communication or electrical equipment room unless this piping serves only that room.
- B. Sprinkler heads and piping within main communication equipment rooms and rooms having electrical gear shall be provided with shields and/or deflectors where required by the AHJ or Owner to protect electrical and/or communications equipment.
- C. Piping shall not be installed above switchboards, panelboards, control panels, motor control centers, individual motor controllers etc. Piping shall not be installed above bus duct unless otherwise show on the Drawings.
- D. Coordinate with Division 26 Contractor to ensure the above listed precautions are met.

PART 4 – REGULATORY REQUIREMENTS

4.1 AUTHORITY HAVING JURISDICTION

- A. Where alterations and/or deviations from the Contract Documents, i.e. Drawings and Specifications, are required by the AHJ, report the requirements to the Architect and secure his written approval before starting the alteration.
- B. Modifications to the Division 23 work required by the AHJ shall be made by the Contractor without additional cost to the Owner.

4.2 CODES AND REFERENCE STANDARDS

- A. All materials and workmanship shall comply with the requirements of the Building, Mechanical, Electrical, Plumbing, Fire, Accessibility, and Energy Codes adopted by the City of **San Antonio**, including all amendments, applicable laws and ordinances and supplementary rules and interpretations. Where Contract Document requirements exceed Code requirements and are permitted under the Code, the Contract Documents shall govern.
- B. In all cases where Underwriter's Laboratories, Inc. have established standards for a particular type material, such material shall comply with these standards or other nationally recognized testing standards acceptable to the Authority Having Jurisdiction. Evidence of compliance shall be the UL "label" or "listing" under Re-Examination Service.
- C. The following specific codes and standards shall apply to this project:

1. ADA Accessibility Guidelines for Buildings and Facilities, 1991 (ADAAG) with current amendments.
 2. Americans with Disabilities Act, Part III, 28 CFR 36, July 26, 1991 (ADA).
 3. Building Services Piping (ASME/ANSI B31.9).
 4. Elimination of Architectural Barriers Act, Texas Department of Licensing and Regulations, Texas Civil Statutes, Article 9102,
 5. Energy Conservation Standard for New State Buildings.
 6. Governing Fire Department requirements.
 7. National Fire Codes (NFPA), current edition.
 8. National Electrical Code (NFPA 70), latest edition.
 9. Occupational Safety and Health Act (OSHA).
 10. Current, applicable safety Code for Elevators and Escalators (ASME A17.1).
 11. Standards for Access to the Handicapped (ANSI 117.1).
 12. Texas Accessibility Standards (TAS), Texas Department of Licensing and Regulations (TDLR), Architectural Barriers Act, Article 9102, Texas Civil Statutes, effective April 1, 1994.
 13. Texas Boiler Law, Chapter 755, Health and Safety Code, Texas Department of Licensing and Regulations.
 14. Current Applicable International Building code with local amendments.
 15. Current Applicable International Mechanical code with local amendments.
 16. Current Applicable International Fire code with local amendments.
 17. Current Applicable International Energy conservation code with local amendments.
 18. Current Applicable Uniform Plumbing code with local amendments.
 19. Current Applicable National Electric code with local amendments.
 20. Current Applicable Supplemental with local amendments.
- D. Refer to Division 01 and the Division 23 Specification Sections hereinafter for additional applicable regulatory requirements.
- 4.3 OWNER'S RULES AND REGULATIONS
- A. Comply with Owner's rules and regulations, as well as Airport Security requirements, as they apply.
- 4.4 DISCREPANCIES
- A. 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 and the Engineer in writing of said discrepancies and apply for an interpretation.
- B. Should the discovery and notification occur after the execution of the Contract, any additional work required for compliance with said regulations shall be paid for as covered by Division 01, providing no work or fabrication of materials has been accomplished in a manner of noncompliance.
- C. 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.

- 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. Undocumented statements will not 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 for completion of the project.

END OF SECTION

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Smith, Jay R. Mfg. Co.
 - 2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 1. Advance Products & Systems, Inc.
 2. CALPICO, Inc.
 3. Metraflex Company (The).
 4. Pipeline Seal and Insulator, Inc.
 5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 2. Pressure Plates: Carbon steel or Stainless steel.
 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, or Stainless steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 1. Presealed Systems.
- B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

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

- B. 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 airtight. Provide close fitting metal collar or escutcheon covers, as appropriate, at both sides of penetration.
- C. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.
- D. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed. Sleeves through floors shall have welded waterstop rings. Sleeves shall be sealed watertight to floors and pipe
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 3 inches (50 mm) above finished floor level.
 - 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- E. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."
- F. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide 1-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
 - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
 - 3. Install section of cast-iron soil pipe to extend sleeve to 3 inches (50 mm) above finished floor level.
 - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves or Sleeve-seal fittings.
 - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel wall sleeves or Galvanized-steel-pipe sleeves.
 - 2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
 - 3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
 - 4. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6 (DN 150): Stack-sleeve fittings or Sleeve-seal fittings.

- b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves or Stack-sleeve fittings.
- 5. Interior Partitions:
 - a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

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

- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type or one-piece, cast-brass type with rough-brass finish or split-casting brass type with concealed hinge.
 - g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type or one-piece, cast-brass type with rough-brass finish or split-casting brass type with concealed hinge.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Inserts and Rods
2. Flashing for Mechanical Piping and Equipment
3. Metal pipe hangers and supports.
4. Trapeze pipe hangers.
5. Fiberglass pipe hangers.
6. Metal framing systems.
7. Fiberglass strut systems.
8. Thermal-hanger shield inserts.
9. Fastener systems.
10. Pipe stands.
11. Equipment supports.

B. Related Sections:

1. Specification section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Specification Section for "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
3. Specification Section for "Vibration Controls for HVAC Piping and Equipment" for vibration isolation devices.
4. Specification section for "Metal Ducts" and Section for "Nonmetal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment support, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

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

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer Show fabrication and installation details and include calculations for the following: include Product Data for components:
 1. Wall Supports
 2. Hangers and Hanger Attachments
 3. Details of Pip Penetrations
 4. Sleeves
 5. Sealing and UL Approved Fire Stop Assemblies
 6. Floor Supports
 7. Trapeze pipe hangers.
 8. Metal framing systems.
 9. Pipe stands.
 10. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Detail fabrication and assembly of trapeze hangers.
 2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.7 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 INSERTS AND RODS

- A. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.
- B. Use drilled expansion anchors in existing concrete structures.
- C. Where concrete slabs form finished ceiling, finish inserts, flush with slab surface.

- D. Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab.
- E. Provide tunnel support system to General Contractor for insertion into form work prior to concrete placement.
- F. Provide electro-galvanized steel hanger rods, threaded both ends, threaded one end or continuous threaded.
- G. Size inserts to suit threaded hanger rods.

2.2 FLASHING

- A. Steel Flashing: 26-gauge galvanized steel.
- B. Lead Flashing: five (5) lb./sq.ft. sheet lead for water-proofing, one (1) lb./sq.ft. sheet lead to soundproofing.
- C. Safes: five (5) lb./sq.ft. sheet lead or eight (8) mil thick neoprene.
- D. Caps: Steel, 22-gauge minimum, 16 gauge at fire resistant structures.

2.3 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
- B. Stainless-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel or hot dipped galvanized. Electroplated zinc rods are not allowed.
- C. Copper Pipe Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.4 TRAPEZE PIPE HANGERS

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

2.5 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. Flex-Strut Inc.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut Corporation; Tyco International, Ltd.
 - g. Wesanco, Inc.
 3. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
 4. Standard: MFMA-4.
 5. Channels: Continuous slotted steel channel with inturned lips.
 6. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
 8. Retain one of four subparagraphs below for coating.
 9. Metallic Coating: Hot-dipped galvanized
 10. Paint Coating: Epoxy
 11. Plastic Coating: Polyurethane

2.6 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carpenter & Paterson, Inc.
 2. Clement Support Services.
 3. ERICO International Corporation.
 4. National Pipe Hanger Corporation.
 5. PHS Industries, Inc.
 6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 7. Piping Technology & Products, Inc.
 8. Rilco Manufacturing Co., Inc.
 9. Value Engineered Products, Inc.
 10. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa)] minimum compressive strength and vapor barrier.

- B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.7 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless- steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.8 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- D. Pipe Support Schedule:

STEEL PIPE SIZE	MAX HANGER SPACING	HANGER ROD DIAMETER
Inches	Feet	Inches
1/2 to 1-1/4	6	3/8
1-1/2 to 2	10	3/8
2-1/2 to 3	10	1/2
4 to 6	12	5/8
8 to 12	14	7/8
14 to 16	22	1
18 and over	26	1-1/4

2.9 EQUIPMENT SUPPORTS

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

2.10 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 INSERTS

- A. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.
- B. Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over four (4) inches or ducts over 60 inches wide.
- C. Where concrete slabs form finished ceiling, finish inserts, flush with slab surface.

3.2 FLASHING

- A. Flash and counter flash where mechanical equipment passes through weather or waterproofed walls, floor, and roofs. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricates from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

- C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.
- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.
- F. Thermal-Hanger Shield Installation: Install in pipe hangers or shield for insulated piping.
- G. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturers. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to the manufacturer's written instructions.
- H. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount them on smooth roof surface. Do not penetrate roof membrane.
- I. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- K. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- L. Install lateral bracing with pipe hangers and supports to prevent swaying.
- M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- N. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- P. Insulated Piping:
 - 1. Attach clamps and spacers to piping.

- a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches long and 0.048 inch thick.
 - b. NPS 4 (DN 100): 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
 - d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
 - e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
 5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercutting or overlapping.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

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

- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm) and then apply zinc metal paint at the cut portion to prevent corrosion.

3.6 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint with a brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Cleaning and touchup painting of field welds bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.7 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports or metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb (340 kg).
 - b. Medium (MSS Type 32): 1500 lb (680 kg).
 - c. Heavy (MSS Type 33): 3000 lb (1360 kg).
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

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

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
4. 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 3/4" 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:

Nominal IPS	Metal Thickness of Shield	Lengths
up thru 2"	14 gauge	12"
thru 6"	12 gauge	16"
and above	10 gauge	20"

5. Insert Location: Between support shield and piping and under the finish jacket.
6. Insert Configuration: Minimum 2" inches longer than length of shield, of same thickness and contour as adjoining insulation; may be factory fabricated.
7. The shields at support points shall be secured with 1/2" x 0.016" stainless steel bands and seals.
8. 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 5-lbs/ft³ 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 and shall be faced with factory applied FSK/ASJ vapor barrier and fitted with a galvanized steel saddle, for all pipe sizes 3/4" or larger. The load bearing insulation at the support shall be capable of withstanding the maximum static compressive loads generated by pipe supported at the centers, Pipe loads greater than those generated at the support centers 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.

9. The Insulation at supports shall be Foamglas HLB Blocks. HLB 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 HLB Block, for all pipe sizes 1 1/2" and larger

Nominal Pipe Size (Inches)	3/4	1	1 1/4	2	2 1/2	3	4	6	8	10	12	14	16	18	20	24
Max support centers (feet)																
Sch 80 pipe filled with water covered with 1" of Standard Insulation	6.5	6.5	6.5	10	10	10	10	10	14	14	14	20	20	20	20	20
Metal Saddle Gauge (Galvanized Steel)	22	22	22	20	20	20	16	14	14	14	14	14	114	14	14	14
Length of HLB Block (inches)	6	6	6	6	6	6	6	9	9	9	9	9	9	12	12	12

3.9 LOW PRESSURE DUCT SUPPORT SCHEDULE:

- A. All horizontal ducts up to and including 40 inches in their greater dimension shall be supported by means of No. 18 U.S. gauge band iron hangers attached to the ducts by means of screws, rivets, or clamps and fastened to above inserts with toggle bolts, beam clamps or other approved means. Duct shall have at least one pair of supports 8' 0" on centers. Clamps shall be used to fasten hangers to reinforcing on sealed ducts.

10. Horizontal ducts larger than 40 inches in their greatest dimension shall be supported by means of hanger rods bolted to angle iron trapeze hangers. Duct shall have at least one pair of supports 8' 0" on centers according to the following:

Length	Angle	Rod Diameter
4' 0"	1-1/2" x 1-1/2" x 1/8"	1/4"
6' 0"	1-1/2" x 1-1/2" x 1/8"	1/4"
8' 0"	2" x 2" x 1/8"	5/16"
10' 0"	3" x 3" x 1/8"	3/8"

11. Vertical 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.

END OF SECTION

SECTION 230548 - VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:

- 1. Isolation pads.

1.3 SUBMITTALS

- A. Product Data: For the following:

- 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

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

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

- 1. Ace Mountings Co., Inc.
- 2. Amber/Booth Company, Inc.
- 3. B-Line Systems, Inc.
- 4. Isolation Technology, Inc.
- 5. Kinetics Noise Control.
- 6. Mason Industries.
- 7. Vibration Eliminator Co., Inc.
- 8. Vibration Isolation.
- 9. Vibration Mountings & Controls, Inc.

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

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

END OF SECTION

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Pipe labels.
 - 3. Duct labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Ceiling markers.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.
- F. Refer to Section 230500 "Common Work Results for HVAC".

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Refer to Section 230500 "Common Work Results for HVAC".

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch minimum thickness, Stainless steel, 0.025-inch minimum thickness, or Aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
 3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 4. Fasteners: Stainless-steel rivets or self-tapping screws.
 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 2. Letter Color: Black.
 3. Background Color: White.
 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number.
- D. Equipment Label Schedule: For each item of equipment to be labeled. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.
- 2.2 PIPE LABELS
- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pre-tensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: At least 1-1/2 inches high.

- E. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.3 DUCT LABELS

- A. Material and Thickness:
 - 1. For non-plenum spaces: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, or vinyl with pressure sensitive acrylic adhesive backing.
 - 2. In plenums: Minimum 1.6 mil aluminum with high tack permanent pressure sensitive adhesive backing. Product shall meet ASTM E 84 requirements for plenum installation.
- B. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- C. Minimum Label Size: 2-1/4 inch high, with length to suit required label content.
- D. Minimum Letter Size: Minimum 1-1/2 inches high.
- E. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- F. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction. On each label, prefix the system designation with the associated equipment number (example: AHU-1 SUPPLY AIR).
 - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.4 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
 - 1. Stencil Material: Aluminum.
 - 2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
 - 1. Tag Material: Brass or Anodized Aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or

modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 CEILING MARKERS

- A. Round permanent color dot sticker 3/4 inch size diameter color coded head. Color code as follows (coordinate with Owner):

1. Yellow - HVAC equipment
2. Red - Fire dampers/smoke dampers
3. Green - Plumbing valves
4. Blue - Heating/cooling valves

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.
- C. Do not install labels in return air plenums unless labels are plenum rated.
- D. Furnish and install equipment labels for all equipment, associated control panels and associated electrical panels. This shall include, but is not limited to:
 1. Air Handling Units
 2. Fan Coil Units
 3. Rooftop Units
 4. Condensing Units
 5. Split Systems
 6. Fans
 7. Pumps
 8. Chillers
 9. Boilers
 10. Water Treatment Equipment
 11. Tanks
 12. Air Terminal Units
 13. VFD enclosures
 14. Starters
 15. Control panels
 16. Air flow measuring stations
 17. Job site mounted control components

3.3 PIPE LABEL INSTALLATION

- A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.

- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

- C. Provide a double ended arrow marker when flow can be in either or both directions.

- D. Pipe Label Color Schedule:
 - 1. Chilled-Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 - 2. Condenser-Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 - 3. Heating Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 - 4. Refrigerant Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.
 - 5. Natural Gas
 - a. Background Color: Yellow.
 - b. Letter Color: Black.
 - 6. Low-Pressure Steam Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.
 - 7. High-Pressure Steam Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.
 - 8. Steam Condensate Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.
 - 9. All Others:
 - a. Follow ASME A13.1

- E. Do not install labels in return air plenums unless plenum rated.
- F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

3.4 DUCT LABEL INSTALLATION

- A. Install duct labels with permanent adhesive on air ducts in the following color codes:
 - 1. Blue or Green background with White letters: For supply, exhaust, outside, relief, return, and mixed-air ducts.
 - 2. ASME A13.1 Colors and Designs: For hazardous material exhaust.
- B. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.
- C. Locate labels:
 - 1. Near points where ducts enter into concealed spaces.
 - 2. At access panels and similar access points that permit view of concealed duct.
 - 3. On duct access doors, indicating purpose of access (example: fire damper).
 - 4. At maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.
 - 5. Near major equipment items and other points of origination and termination
- D. Do not install labels in return air plenums unless plenum rated.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:
 - a. Chilled Water: 1-1/2 inches, round.
 - b. Condenser Water: 1-1/2 inches, round.
 - c. Hot Water: 1-1/2 inches, round.
 - d. Refrigerant: 1-1/2 inches, round.
 - e. Gas: 1-1/2 inches, round.
 - f. Low-Pressure Steam: 1-1/2 inches, round.
 - g. High-Pressure Steam: 1-1/2 inches, round.
 - h. Steam Condensate: 1-1/2 inches, round.
 - 2. Valve-Tag Color:
 - a. Chilled Water: Natural or Green.
 - b. Condenser Water: Natural or Green.
 - c. Hot Water: Natural or Green.
 - d. Refrigerant: Natural or Yellow.
 - e. Gas: Natural or Yellow.
 - f. Low-Pressure Steam: Natural or Yellow.

- g. High-Pressure Steam: Natural or Yellow.
- h. Steam Condensate: Natural or Yellow.
- 3. Letter Color:
 - a. Chilled Water: White.
 - b. Condenser Water: White.
 - c. Hot Water: White.
 - d. Refrigerant: Black.
 - e. Gas: Black.
 - f. Low-Pressure Steam: Black.
 - g. High-Pressure Steam: Black.
 - h. Steam Condensate: Black.

- C. Do not install tags in return air plenums unless plenum rated.

3.6 CEILING MARKER INSTALLATION

- A. Provide colored dots to locate valves, dampers, and other concealed equipment above lay-in type ceilings. Install on the surface of the ceiling grid 'T' bar and/or on the frame of an access door. Locate in corner of tile closest to equipment.

END OF SECTION

SECTION 230593 - TESTING, ADJUSTING, and BALANCING for HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE

- A. This section provides for the testing and balancing of all systems and equipment, to be provided by 3rd party hired by the Owner.
- B. These tests are required to determine that all systems and equipment involved may be safely energized and function properly.
- C. Perform tests by and under the supervision of fully experienced and qualified personnel. Advise each respective manufacturer's representative of tests on their equipment.
- D. Record all test data.
- E. Each section of Divisions 22 and 23 that has products or systems listed herein, incorporates this section by reference and is incomplete without the required tests stated herein.

1.3 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.

1.4 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

1.5 SUBMITTALS

- A. Qualification Data: Within 15 (fifteen) days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

- B. Contract Documents Examination Report: Within 30 (thirty) days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 30 (thirty) days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. Certified TAB reports.
- E. Sample report forms.
- F. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.6 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by NEBB or TABB.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by NEBB or TABB.
 - 2. TAB Technician: Employee of the TAB contractor and who is certified by NEBB or TABB as a TAB technician.
- B. TAB Conference: Meet with Construction Manager and on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
 - 1. Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Coordination and cooperation of trades and subcontractors.
 - d. Coordination of documentation and communication flow.
- C. Certify TAB field data reports and perform the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard TAB contractor's forms approved by Construction Manager.
- E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."
- F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

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

1.7 PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- J. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

- K. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- M. Examine system pumps to ensure absence of entrained air in the suction piping.
- N. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Hydronic systems are filled, clean, and free of air.
 - 3. Automatic temperature-control systems are operational.
 - 4. Equipment and duct access doors are securely closed.
 - 5. Balance, smoke, and fire dampers are open.
 - 6. Isolating and balancing valves are open and control valves are operational.
 - 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
 - 1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
 - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230700 "HVAC Insulation".
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts within Mechanical Rooms.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 3. Measure static pressure across each component that makes up an air-handling unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 - 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 - 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

6. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes as applicable to achieve indicated air-handling-unit performance.
7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
8. Adjust volume dampers for main duct, sub main ducts, and major branch ducts to indicated airflows within specified tolerances as applicable within work area.
9. Measure airflow of sub main and branch ducts.
 - a. Where sufficient space in sub main and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
10. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
11. Remeasure each sub main and branch duct after all have been adjusted. Continue to adjust sub main and branch ducts to indicated airflows within specified tolerances.

B. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors as applicable.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 3. Measure total system airflow. Adjust to within indicated airflow.
 4. Record final fan-performance data.
- C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 1. Balance variable-air-volume systems the same as described for constant-volume air systems.
 2. Set terminal units and supply fan at full-airflow condition.
 3. Readjust fan airflow for final maximum readings.
 4. Measure operating static pressure at the sensor that controls the supply fan if one is installed, and verify operation of the static-pressure controller.

5. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

3.7 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 1. Manufacturer's name, model number, and serial number.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Efficiency rating.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.8 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.9 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
 1. Entering- and leaving-water temperature.
 2. Water flow rate.
 3. Water pressure drop.
 4. Dry-bulb temperature of entering and leaving air.
 5. Wet-bulb temperature of entering and leaving air for cooling coils.
 6. Airflow.
 7. Air pressure drop.
- B. Measure, adjust, and record the following data for each refrigerant coil:
 1. Dry-bulb temperature of entering and leaving air.
 2. Wet-bulb temperature of entering and leaving air.
 3. Airflow.
 4. Air pressure drop.
 5. Refrigerant suction pressure and temperature.

3.10 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, Outside Air and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 - 2. Heating-Water Flow Rate: Plus or minus 10 percent.
 - 3. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.11 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

3.12 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Fan curves.
 - 2. Manufacturers' test data.
 - 3. Field test reports prepared by system and equipment installers.
 - 4. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB contractor.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB supervisor who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.
 - 13. Data for terminal units, including manufacturer's name, type, size, and fittings.

14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fan performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches (mm), and bore.
 - i. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches (mm), and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
 3. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm (L/s).
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg (Pa).
 - e. Filter static-pressure differential in inches wg (Pa).
 - f. Preheat-coil static-pressure differential in inches wg (Pa).
 - g. Cooling-coil static-pressure differential in inches wg (Pa).
 - h. Heating-coil static-pressure differential in inches wg (Pa).

- i. Outdoor airflow in cfm (L/s).
 - j. Return airflow in cfm (L/s).
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.
- F. Apparatus-Coil Test Reports:
1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch (mm) o.c.
 - f. Make and model number.
 - g. Face area in sq. ft. (sq. m).
 - h. Tube size in NPS (DN).
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
 2. Test Data (Design and Actual Values):
 - a. Air flow rate in cfm (L/s).
 - b. Average face velocity in fpm (m/s).
 - c. Air pressure drop in inches wg (Pa).
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
 - e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
 - f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
 - h. Water flow rate in gpm (L/s).
 - i. Water pressure differential in feet of head or psig (kPa).
 - j. Entering-water temperature in deg F (deg C).
 - k. Leaving-water temperature in deg F (deg C).
 - l. Refrigerant expansion valve and refrigerant types.
 - m. Refrigerant suction pressure in psig (kPa).
 - n. Refrigerant suction temperature in deg F (deg C).
 - o. Inlet steam pressure in psig (kPa).
- G. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches (mm), and bore.
 - h. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.

- e. Sheave make, size in inches (mm), and bore.
- f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
- g. Number, make, and size of belts.
3. Test Data (Design and Actual Values):
 - a. Total airflow rate in cfm (L/s).
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg (Pa).
 - e. Suction static pressure in inches wg (Pa).
- H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F (deg C).
 - d. Duct static pressure in inches wg (Pa).
 - e. Duct size in inches (mm).
 - f. Duct area in sq. ft. (sq. m).
 - g. Indicated air flow rate in cfm (L/s).
 - h. Indicated velocity in fpm (m/s).
 - i. Actual air flow rate in cfm (L/s).
 - j. Actual average velocity in fpm (m/s).
 - k. Barometric pressure in psig (Pa).
- I. Air-Terminal-Device Reports:
 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft. (sq. m).
 2. Test Data (Design and Actual Values):
 - a. Air flow rate in cfm (L/s).
 - b. Air velocity in fpm (m/s).
 - c. Preliminary air flow rate as needed in cfm (L/s).
 - d. Preliminary velocity as needed in fpm (m/s).
 - e. Final air flow rate in cfm (L/s).
 - f. Final velocity in fpm (m/s).
 - g. Space temperature in deg F (deg C).
- J. Instrument Calibration Reports:
 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.

- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.13 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - d. Verify that balancing devices are marked with final balance position.
 - e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Architect.
3. Architect shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.14 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Insulation Materials:
 - a. Cellular glass (Foamglass)
 - b. Flexible elastomeric (Black Rubber Insulation)
 - c. Mineral fiber (Fiberglass)
2. Insulating cements.
3. Adhesives.
4. Mastics.
5. Lagging adhesives.
6. Sealants.
7. Factory-applied jackets.
8. Field-applied fabric-reinforcing mesh.
9. Field-applied cloths.
10. Field-applied jackets.
11. Tapes.
12. Securements.
13. Corner angles.

B. Related Sections:

1. Section 233113 "Metal Ducts."
2. Section 232300 "Refrigerant Piping."

1.3 SUBMITTALS

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

B. Shop Drawings:

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

- C. Qualification Data: For qualified Installer.
- D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Refer to section 230500 Common Work Results for HVAC.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Insulations shall be suitable for applications at temperatures between ZERO deg F to PLUS 450 deg F. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article. Foamglass pipe insulation shall equal to HLB 1200. Insulate fittings associated with foamglass insulation systems with molded, pipe fitting fitting covers with same thickness as adjoining pipe insulation and shall be covered with molded, 25/50, PVC, Zeston fitting covers. Insulate valves associated with foamglass insulation systems with fire retardent, 1" thick, 25/30/50, black, closed cell, foam plastic insulation equal to Armaflex FR insulation applied with mastic approved by the insulation manufacturer.
 - 1. Block Insulation: ASTM C 552, Type I.
 - 2. Special-Shaped Insulation: ASTM C 552, Type III.
 - 3. Board Insulation: ASTM C 552, Type IV.
 - 4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 - 5. Preformed Pipe Insulation with Factory-Applied ASJ ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
 - 6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Insulation shall be suitable for applicable at temperatures between MINUS 70 deg F and PLUS 220 deg F. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Insulations shall be suitable for application at temperatures between PLUS 40 deg F to PLUS 250 deg F. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- I. The entire insulation system and all insulating materials insulation, coverings, jackets, cements, adhesives, miscellaneous items and accessories, etc. shall have a maximum flame spread rating of 25, a maximum fuel contribution rating of 30 and a maximum smoke developmental rating of 50 and shall be suitable for installation in a plenum.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F .
 - 1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.
- E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content that is compliant with the requirements of 40 CFR 59, Subpart D EPA Method 24.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F .
 - 3. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 - 4. Color: White.

- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
 - 1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 - 2. Service Temperature Range: 0 to 180 deg F .
 - 3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 - 4. Color: White.

- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
 - 1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
 - 2. Service Temperature Range: Minus 50 to plus 220 deg F .
 - 3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 - 4. Color: White.

- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 200 deg F .
 - 3. Solids Content: 63 percent by volume and 73 percent by weight.
 - 4. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 - 1. For indoor applications, use lagging adhesives that have a VOC content that is compliant with the requirements of 40 CFR 59, Subpart D EPA Method 24.
 - 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
 - 3. Service Temperature Range: Minus 50 to plus 180 deg F .
 - 4. Color: White.

2.6 SEALANTS

- A. Joint Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Permanently flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 100 to plus 300 deg F .
 - 4. Color: White or gray.
 - 5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.

- B. FSK and Metal Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F .
 - 4. Color: Aluminum.
 - 5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.

- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F .
 - 4. Color: White.
 - 5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D EPA Method 24.

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 - 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 - 4. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
 - 5. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
 - 6. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.

2.9 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. .

2.10 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Metal Jacket:
 - 1. Aluminum Jacket: Comply with ASTM B 209 , Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.

- c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
- d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
- e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

- D. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.

- E. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

- F. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

- G. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.11 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 1. Width: 3 inches .
 - 2. Thickness: 11.5 mils .
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 - 1. Width: 3 inches .
 - 2. Thickness: 6.5 mils .
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.

6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 1. Width: 2 inches .
 2. Thickness: 3.7 mils .
 3. Adhesion: 100 ounces force/inch in width.
 4. Elongation: 5 percent.
 5. Tensile Strength: 34 lbf/inch in width.
- D. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
 1. Width: 3 inches .
 2. Film Thickness: 4 mils .
 3. Adhesive Thickness: 1.5 mils .
 4. Elongation at Break: 145 percent.
 5. Tensile Strength: 55 lbf/inch in width.
- E. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
 1. Width: 3 inches .
 2. Film Thickness: 6 mils .
 3. Adhesive Thickness: 1.5 mils .
 4. Elongation at Break: 145 percent.
 5. Tensile Strength: 55 lbf/inch in width.

2.12 SECUREMENTS

- A. Bands:
 1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing or closed seal.
 2. Aluminum: ASTM B 209 , Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing or closed seal.
 3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
- B. Insulation Pins and Hangers:
 1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

- b. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 - 4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - b. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches .
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 - 5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive-backed base with a peel-off protective cover.
 - 6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
 - 7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- D. Wire: 0.080-inch nickel-copper alloy.

2.13 CORNER ANGLES

- A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch , aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches . Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.
- Q. Piping insulation on all inline mounted P/T ports, circuit setters / calibrated balancing valve pressure ports, strainers, etc. shall be made easily removable so that access to the ports can be readily obtained without destroying the insulation and the strainer baskets can be removed and cleaned without destroying the insulation.
- R. Airflow measuring station pressure ports, access door handles, duct mounted instrumentation, etc., shall be left exposed on warm systems and accessible above the insulation vapor barrier on cold and hot systems.

3.4 PENETRATIONS

- A. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations That Are Not Fire Rated: Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches .
1. Comply with requirements in Division 07 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.
 6. Provide removeable insulation covers on the ends of suction diffusers to facilitate the cleaning of the strainers inside the suction diffusers.

3.6 CELLULAR-GLASS (FOAMGLASS) INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch , and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 MINERAL-FIBER (FIBERGLASS) INSULATION INSTALLATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for a minimum of 75 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.9 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
 1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
- E. Where PVDC jackets are indicated, install as follows:
 1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
 2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
 3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer

to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.

4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.10 FINISHES

- A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.11 DUCT INSULATION SCHEDULE, GENERAL

- A. R-value shall meet requirements of latest adopted version of the International Energy Conservation Code or values listed in this specification, whichever is stricter.
- B. Ducts Requiring Insulation with flexible duct wrap:
 1. Indoor, concealed supply and outdoor air.
 2. Indoor, exposed supply and outdoor air.
 3. Indoor, concealed return.
 4. Indoor, exposed return.
 5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
 6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
 7. Interior surfaces of blank off plates behind louvers or damper openings where existing openings are closed off. Refer to the Drawings.
- C. Items Not Insulated:
 1. Factory-insulated flexible ducts.
 2. Factory-insulated plenums and casings.
 3. Flexible connectors.
 4. Vibration-control devices.
 5. Factory-insulated access panels and doors.

3.12 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, round, rectangular and flat-oval, supply-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2 inches thick and 1.00-lb/cu. ft. nominal density.
- B. Exposed, round, rectangular and flat-oval, supply-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2 inches thick and 1.00-lb/cu. ft. nominal density.
- C. Exposed, round, rectangular and flat-oval, return-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2 inches thick and 1.00-lb/cu. ft. nominal density.
- D. Exposed, round, rectangular and flat-oval, outdoor-air duct insulation, as well as blank off plates, shall be the following:
 - 1. Mineral-Fiber Blanket: 2 inches thick and 1.00-lb/cu. ft. nominal density.

3.13 PIPING INSULATION SCHEDULE, GENERAL

- A. R-value, thickness, and conductivity shall meet requirements of latest adopted version of the International Energy Conservation Code or values listed in this specification, whichever is stricter.
- B. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.14 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Deg F :
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Fire-Wrap: 1/2 inch thick.
 - b. Flexible Elastomeric: 1 inch thick.
- B. Refrigerant Suction and Hot Gas Piping, VRF Refrigerant Piping:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
- C. Chilled Water, above 40 Deg F :
 - 1. NPS 8 and Smaller: Insulation shall be:
 - a. Mineral Fiber ASJ-SSL: 2 inches thick.
 - 2. NPS 1 inch and smaller: Insulation shall be the following:
 - a. Mineral Fiber ASJ-SSL: 1 inch thick.
- D. Heating-Hot-Water Supply and Return, 220 Deg F and below:
 - 1. NPS 8 through 1-1/4 inch: Insulation shall be the following:
 - a. Mineral Fiber ASJ-SSL: 2 inches thick

2. NPS 1 inch and smaller: Insulation shall be the following:
 - a. Mineral Fiber ASJ-SSL: 1 inch thick
 - E. All cold surfaces associated with the HVAC system (materials, piping, ductwork or equipment) subject to sweating shall be insulated and provided with an external vapor barrier to a sufficient degree so as not to sweat under the normal conditions of use.
- 3.15 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE
- A. Chilled, Hot Water Piping, Condensate Drains, Refrigerant Suction and Hot Gas Piping, VRF Refrigerant Piping:
 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 2 inches thick (chilled water, heating hot water).
 - b. Flexible Elastomeric: 2 inches thick (condensate drains, refrigerant suction and hot gas piping, all VRF refrigerant piping).
- 3.16 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE
- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
 - B. If more than one material is listed, selection from materials listed is Contractor's option.
 - C. Exposed, Chilled, Hot, Condensate Piping:
 1. Aluminum, Corrugated, 0.040 inch thick.
- 3.17 FIRE-RATED INSULATION SYSTEMS
- A. Fire-Rated Blanket: High Temperature, flexible, single-layer blanket insulation with FSK jacket that is tested and certified to provide a 2-hour Fire Rating by a NRTL acceptable to the A.H.J. Fire-Rated flexible blanket to be UNIFRAX, FYREWRAP 1.5, or equal.

END OF SECTION

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
 - 2. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
 - 3. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

1.4 SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
 - 1. Filter dryers.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
 - 1. Shop Drawing Scale: 1/4 inch equals 1 foot (1:50).
 - 2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.8 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.9 COORDINATION

- A. Coordinate size and location of equipment supports. This Contractor is responsible for support of his equipment. Submit details to the Architect for approval.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8.
- F. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
 - 4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).
 - 5. Maximum Operating Temperature: 250 deg F (121 deg C).
- G. 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:
- H. Manufacturers: Subject to compliance with manufacturer requirements, provide products by one of the following:
 - 1. Atofina Chemicals, Inc.
 - 2. DuPont Company; Fluorochemicals Div.
 - 3. Honeywell, Inc.; Genetron Refrigerants.

4. INEOS Fluor Americas LLC.
- I. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

- A. Suction Lines NPS 1-1/2 (DN 40) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- B. Suction Lines NPS 2 to NPS 3-1/2 (DN 50 to DN 90) for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
- C. Safety-Relief-Valve Discharge Piping: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3.2 PIPING INSTALLATION

- A. Install all piping per manufacturer's recommendation.
- 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 Shop Drawings.
- C. Install refrigerant piping according to ASHRAE 15.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Install piping adjacent to machines to allow service and maintenance.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083100 "Access Doors and Panels" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

- N. Slope refrigerant piping as manufacturer recommends.
- O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- Q. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."
- R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified hereinbefore.

3.3 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.4 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor products are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet (6 m) or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1/2 (DN 15): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
 - 2. NPS 5/8 (DN 18): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
 - 3. NPS 1 (DN 25): Maximum span, 72 inches (1800 mm); minimum rod size, 1/4 inch (6.4 mm).
 - 4. NPS 1-1/4 (DN 32): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
 - 5. NPS 1-1/2 (DN 40): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).

6. NPS 2 (DN 50): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
7. NPS 2-1/2 (DN 65): Maximum span, 108 inches (2700 mm); minimum rod size, 3/8 inch (9.5 mm).
8. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
9. NPS 4 (DN 100): Maximum span, 12 feet (3.7 m); minimum rod size, 1/2 inch (13 mm).

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 2 (DN 50): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
2. NPS 2-1/2 (DN 65): Maximum span, 11 feet (3.4 m); minimum rod size, 3/8 inch (9.5 mm).
3. NPS 3 (DN 80): Maximum span, 12 feet (3.7 m); minimum rod size, 3/8 inch (9.5 mm).
4. NPS 4 (DN 100): Maximum span, 14 feet (4.3 m); minimum rod size, 1/2 inch (13 mm).

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.6 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
4. Charge system with a new filter-dryer core in charging line.

3.7 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Verify that compressor oil level is correct.
 2. Open compressor suction and discharge valves.
 3. Open refrigerant valves except bypass valves that are used for other purposes.
- E. Replace core of replaceable filter dryer, as applicable, after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 23 3113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All exposed duct work shall be double wall insulated round and supported by cable hangers only. All exposed round ductwork shall be connected by gasket slip/coupling duct connector to meet ASHRAE Standard 90.1. no flange connection will be accepted.
- C. All exposed ductwork shall be supported by stainless steel cable hanger.
- D. Flexible ducts shall not be more than 5'-0" in length, shall be installed as indicated in the diffuser connection detail, and shall be Flexmaster Type TL M or approved equal.

1.2 FACTORY LINED ACOUSTICAL DUCTS:

- A. Where indicated on the Drawings, furnish and install double wall internally insulated duct and fittings.
- B. Duct shall consist of outer metal pressure shell, 2" thick glass fiber insulation and internal perforated metal liner.
- C. Duct and fittings shall be equal to Acousti K 27 as manufactured by United McGill Sheet Metal Company or approved equal.

1.3 SUMMARY

- A. Section Includes:
 - 1. Single-wall rectangular ducts and fittings.
 - 2. Double-wall rectangular ducts and fittings.
 - 3. Single-wall round and flat-oval ducts and fittings.
 - 4. Double-wall round and flat-oval ducts and fittings.
 - 5. Sheet metal materials.
 - 6. Duct liner.
 - 7. Sealants and gaskets.
 - 8. Hangers and supports.
- B. Related Sections:
 - 1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
 - 2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct

Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.5 SUBMITTALS

- A. Product Data: For each type of the following products:

- 1. Liners and adhesives.
- 2. Sealants and gaskets.

- B. Shop Drawings: Submit shop drawings for review before fabrication or installing ductwork.

- 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
- 2. Factory- and shop-fabricated ducts and fittings.
- 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
- 4. Elevation of top of ducts.
- 5. Dimensions of main duct runs from building grid lines.
- 6. Fittings.
- 7. Reinforcement and spacing.
- 8. Seam and joint construction.
- 9. Penetrations through fire-rated and other partitions.
- 10. Equipment installation based on equipment being used on Project.
- 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
- 12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

- C. Delegated-Design Submittal:

- 1. Sheet metal thicknesses.
- 2. Joint and seam construction and sealing.
- 3. Reinforcement details and spacing.
- 4. Materials, fabrication, assembly, and spacing of hangers and supports.
- 5. Design Calculations: Calculations , including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

1.6 QUALITY ASSURANCE

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

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

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

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

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. McGill AirFlow LLC.
 - 2. Sheet Metal Connectors, Inc.
- B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.
- C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- F. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
 - 1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

- G. Inner Duct: Minimum 0.028-inch solid sheet steel.
- H. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- I. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. McGill AirFlow LLC.
 - b. Sheet Metal Connectors, Inc.
 - c. Spiral Manufacturing Co., Inc.
 - d. Spot Spiral pipe of Texas.
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - 2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. McGill AirFlow LLC.
 2. SEMCO Incorporated.
 3. Sheet Metal Connectors, Inc.
 4. Spot Spiral pipe of Texas.
- B. Double wall exposed duct shall utilize the gasketed slip/coupling for joining duct together. No flanged duct connection will be accepted on all exposed duct. Concealed round duct can use the flanged duct connection.
- C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.
- D. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
 2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
 3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- E. Inner Duct: Minimum 0.028-inch solid sheet steel.
- F. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

2.5 SHEET METAL MATERIALS

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

- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
 - C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60.
 - 2. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.
 - D. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
 - E. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
 - F. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
 - G. Factory- or Shop-Applied Antimicrobial Coating:
 - 1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
 - 2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 - 3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested according to ASTM D 3363.
 - 4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
 - 5. Shop-Applied Coating Color: White.
 - 6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.
 - H. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
 - I. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.
- 2.6 DUCT LINER
- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville.
 - b. Knauf Insulation.

- c. Owens Corning.
 2. Maximum Thermal Conductivity:
 - a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compounds shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 4. Solvent -Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - a. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA Inc.
 - b. Armacell LLC.
 - c. Rubatex International, LLC
 2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
 3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
 - a. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Insulation Pins and Washers:
 1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- D. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
 1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 3. Butt transverse joints without gaps, and coat joint with adhesive.
 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
 - a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.7 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 2. Tape Width: 4 inches .
 3. Sealant: Modified styrene acrylic.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 7. Service: Indoor and outdoor.
 8. Service Temperature: Minus 40 to plus 200 deg F.
 9. Substrate: Compatible with galvanized sheet steel, stainless steel, or aluminum.
 10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Water-Based Joint and Seam Sealant:
 1. Application Method: Brush on.
 2. Solids Content: Minimum 65 percent.
 3. Shore A Hardness: Minimum 20.
 4. Water resistant.

5. Mold and mildew resistant.
 6. VOC: Maximum 75 g/L (less water).
 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 8. Service: Indoor or outdoor.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Solvent-Based Joint and Seam Sealant:
1. Application Method: Brush on.
 2. Base: Synthetic rubber resin.
 3. Solvent: Toluene and heptane.
 4. Solids Content: Minimum 60 percent.
 5. Shore A Hardness: Minimum 60.
 6. Water resistant.
 7. Mold and mildew resistant.
 8. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 9. VOC: Maximum 395 g/L.
 10. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
 11. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
 12. Service: Indoor or outdoor.
 13. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- E. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
 2. Type: S.
 3. Grade: NS.
 4. Class: 25.
 5. Use: O.
- F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- G. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.
- H. Slip Fit duct joint:
1. Use Gasket-Tite where the sealant is integral to the joint and on the inside. Full and consistent seal at all 360 degrees of the joint circumference.

2.8 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts. The duct shall be supported by a corrosion resistant metal spiral, or a coated spring steel helix and solid inner liner mechanically interlocked or permanently bonded to the helix wire.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round and flat-oval ducts in maximum practical lengths.
- D. Install ducts with the fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
 - H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
 - I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
 - J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
 - K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.
 - L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."
 - M. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
 - N. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.
 - O. Connect terminal units to medium or high pressure ducts directly or with two feet maximum length of flexible duct. Do not use flexible duct to change direction. Allow for a minimum of 3 diameters of straight duct to the entrance of all terminal units.
 - P. Connect diffusers with 5'-0" maximum length or troffer boots with 2' maximum length of flexible duct to low pressure ducts. Hold in place with strap or clamp, and seal as specified.
 - Q. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- 3.2 INSTALLATION OF EXPOSED DUCTWORK
- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
 - B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
 - C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
 - D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
 - E. Repair or replace damaged sections and finished work that does not comply with these requirements.
 - F. Use cable hanger system (Gripple- ductmate Cable shark)

3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Outdoor, Supply-Air Ducts: Seal Class A.
 - 3. Outdoor, Exhaust Ducts: Seal Class C.
 - 4. Outdoor, Return-Air Ducts: Seal Class C.
 - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
 - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
 - 7. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 8. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
 - 10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
 - 11. Conditioned Space, Exhaust Ducts: Seal Class B.
 - 12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- G. Externally insulated ducts shall be supported on full trapeze hangers in accordance with the SMACNA Standards, Figure 4-5.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Randomly test 10 percent of all duct systems for leakage in accordance with Section 4 of SMACNA HVAC Air Duct Leakage Test Manual, current edition. If leakage test results exceed SMACNA's allowable leakage rates, then entire duct systems shall be tested
 - 3. Test the following systems:
 - a. Supply Air Duct system.
 - 1) Round / Rectangular Supply-Air Duct Downstream of Air Terminal Units: 3 cfm/100 sq. ft. at 1-inch wg.
 - 2) Round and Flat-Oval Supply-Air Duct Upstream of Air Terminal Units: 3 cfm/100 sq. ft. at 4-inch wg.
 - 3) Rectangular Supply-Air Duct Upstream of Air Terminal Units: 6 cfm/100 sq. ft. at 5-inch wg.
 - 4. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 5. Test for leaks before applying external insulation.
 - 6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
- C. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
 - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.8 DUCT CLEANING

- A. Clean new and existing duct system(s) before testing, adjusting, and balancing.
- B. Protect and clean ductwork during construction. Before turning the installation over to the Owner, all ducts should be cleaned. If not, contractor shall blow all dust and dirt that has collected in the ducts.
- C. Use service openings for entry and inspection.
 - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
 - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 - 3. Remove and reinstall ceiling to gain access during the cleaning process.
- D. Particulate Collection and Odor Control:
 - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 - 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- E. Clean the following components by removing surface contaminants and deposits:
 - 1. Air outlets and inlets (registers, grilles, and diffusers).
 - 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 - 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 - 4. Coils and related components.
 - 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 - 6. Supply-air ducts, dampers, actuators, and turning vanes.
 - 7. Dedicated exhaust and ventilation components and makeup air systems.
- F. Mechanical Cleaning Methodology:
 - 1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 - 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 - 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
 - 4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
 - 5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
 - 6. Provide drainage and cleanup for wash-down procedures.

7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.9 START UP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated. :

- B. Liner:

1. Supply Air Ducts: Type I Flexible elastomeric, thickness as required for R-8.
2. Return Air Ducts: Type I Flexible elastomeric, thickness as required for R-8.

- C. Double-Wall Duct Interstitial Insulation:

1. Supply Air Ducts: thickness as required for R-8.
2. Return Air Ducts: thickness as required for R-8.

- D. Elbow Configuration:

1. Radius type rectangular elbows shall have a centerline radius of 1 1/2 times the duct diameter or width. The contractor shall have the option to substitute short radius vaned elbows, but shall request the substitution at the time of submittal of Shop Drawings. Provide turning vanes in all rectangular radius elbows and offsets
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam Welded.

- E. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.

End of Section

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Manual volume dampers
2. Control dampers
3. Fire dampers
4. Combination fire and smoke dampers
5. Flange connectors
6. Turning vanes
7. Remote damper operators
8. Duct-mounted access doors
9. Flexible connectors
10. Flexible ducts
11. Duct accessory hardware

B. Related Sections:

1. Section 283111 "Digital, Addressable Fire-Alarm System".

1.3 SUBMITTALS

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

1. Manual dampers.
2. Fire dampers.
3. Fire/smoke dampers.
4. Flexible connectors.
5. Accessories.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control damper installations.
 - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, installations, including sleeves; and duct-mounted access doors, as well as remote damper operators.

- e. Wiring Diagrams: For power, signal, and control wiring.
- C. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.
- D. Refer to Section 230500 "Common Work Results for HVAC."

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems".
- B. Comply with AMCA 500-D testing for damper rating.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653.
 - 1. Galvanized Coating Designation: G90 .
 - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a mill finish for concealed ducts and No. 4 finish for exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B 209 , Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 - 1. Standard leakage rating, with linkage outside airstream.
 - 2. Suitable for horizontal or vertical applications.
 - 3. Frames:
 - a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.

4. Blades:
 - a. Multiple or single blade. (max. 8" single blade)
 - b. Parallel-blade or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized steel, 0.064 inch thick.
5. Blade Axles: Stainless steel.
6. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
7. Tie Bars and Brackets: Galvanized steel.
8. Provide manual volume dampers installed in externally wrapped ductwork with a stand-off bracket and locking quadrant to ensure that the handle can be adjusted without disturbing the insulation vapor barrier.
9. Manual volume damper (MVD) blades shall be constructed of 16 gauge minimum thickness metal.

B. Jackshaft:

1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.3 CONTROL DAMPERS

- A. Ultra-low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

B. Frames:

1. Hat or U or Angle shaped.
2. Galvanized-steel channels, 0.064 inch thick.
3. Mitered and welded corners.

C. Blades:

1. Multiple blade with maximum blade width of 8 inches .
2. Opposed-blade design.
3. Stainless steel.
4. 0.064 inch thick.
5. Blade Edging: Closed-cell neoprene edging.

D. Blade Axles: 1/2-inch- diameter; stainless steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F .

F. Bearings:

1. Oil-impregnated bronze.

2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

3. Thrust bearings at each end of every blade.

2.4 FIRE DAMPERS

A. Type: Dynamic ; rated and labeled according to UL 555 by an NRTL.

B. Closing rating in ducts up to 6-inch wg static pressure class and minimum 4000-fpm velocity.

C. Fire Rating: 1-1/2 hours.

D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: thickness shall be as required to meet all applicable code requirements and of length to suit application.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

2.5 COMBINATION FIRE AND SMOKE DAMPERS

A. Type: Dynamic ; rated and labeled according to UL 555 and UL 555S by an NRTL.

B. Closing rating in ducts up to 6-inch wg static pressure class and minimum 4000-fpm velocity.

C. Fire Rating: 1-1/2 hours.

D. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

E. Heat-Responsive Device: Electric remote resettable link and switch package, factory installed, rated.

F. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

- G. Leakage: Class I.
- H. Rated pressure and velocity to exceed design airflow conditions.
- I. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application. Thickness of sleeve shall be as required to meet all applicable code requirements. Provide with factory-furnished silicone caulking if required by authorities having jurisdiction.
- J. Damper Motors: Two-position action.
- K. Motors:
 - 1. Motor Sizes: Motors shall be large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230900 "Instrumentation and Control for HVAC" and applicable Division 26 Sections.
 - 3. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf .
 - 4. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F .
 - 5. Electrical Connection: Coordinate motor electrical characteristics with the electrical Division.
- L. Accessories:
 - 1. Auxiliary switches for signaling, fan control, and position indication.
 - 2. Test and reset switches, damper and remote mounted.

2.6 FLANGE CONNECTORS

- A. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- B. Material: Galvanized steel.
- C. Gage and Shape: Match connecting ductwork.

2.7 TURNING VANES

- A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
- C. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions. Provide turning vanes with extended trailing edge.

2.8 REMOTE DAMPER OPERATORS

- A. Description: Cable system designed for remote manual damper adjustment.
- B. Tubing: Brass.
- C. Cable: Stainless steel.
- D. Wall-Box Mounting: Recessed, 2 inches deep.
- E. Wall-Box Cover-Plate Material: Stainless steel.

2.9 DUCT-MOUNTED ACCESS DOORS

- A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
 - 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 48 Inches : Three hinges and two compression latches with outside and inside handles.
 - d. Access Doors Larger Than 24 by 48 Inches : Four hinges and two compression latches with outside and inside handles.
- B. Pressure Relief Access Door:
 - 1. Door and Frame Material: Galvanized sheet steel.
 - 2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
 - 3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
 - 4. Factory set at 4-inch wg.
 - 5. Doors close when pressures are within set-point range.
 - 6. Hinge: Continuous piano.
 - 7. Latches: Cam.
 - 8. Seal: Neoprene or foam rubber.
 - 9. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.10 FLEXIBLE CONNECTORS

- A. Materials: Flame-retardant or noncombustible fabrics.
- B. Coatings and Adhesives: Comply with UL 181, Class 1.

- C. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd. .
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F .

- D. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
 - 1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 - 2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 - 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.11 FLEXIBLE DUCTS

- A. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm .
 - 3. Temperature Range: Minus 20 to plus 210 deg F .
 - 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.

- B. Maximum length 3'-0". Use only for final alignment between diffusers and ductwork.

- C. Flexible Duct Connectors:
 - 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches , to suit duct size.

2.12 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
- D. Set dampers to fully open position before testing, adjusting, and balancing.
- E. Install test holes at fan inlets and outlets and elsewhere as indicated.
- F. Install fire dampers according to UL listing.
- G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream and downstream from duct filters.
 - 3. At outdoor-air intakes and mixed-air plenums.
 - 4. At drain pans and seals.
 - 5. Downstream from control dampers and equipment.
 - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 7. At each change in direction and at maximum 50-foot spacing.
 - 8. Control devices requiring inspection.
 - 9. Elsewhere as indicated.
- H. Install access doors with swing against duct static pressure.
- I. Access Door Sizes (Doors to be as large as possible):
 - 1. Two-Hand Access: 16 by 10 inches .
 - 2. Head and Hand Access: 20 by 14 inches .
 - 3. Head and Shoulders Access: 24 by 18 inches .
- J. Label access doors according to Section 230533 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- K. Install flexible connectors to connect ducts to equipment.
- L. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- M. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

- N. Connect diffusers to ducts with maximum 24-inch lengths of flexible duct clamped or strapped in place.
- O. Connect flexible ducts to metal ducts with draw bands . The maximum length of flexible duct allowed on this project is 3'-0". Install flexible duct as straight as possible. Do not install flexible duct with bends or offsets. Flexible ducts are not to be used as elbows, fittings or major offsets but are to be used for minor alignment purposes.
- P. Install duct test holes where required for testing and balancing purposes.
- Q. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 - 4. Inspect turning vanes for proper and secure installation.
 - 5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Air Distribution Devices (Diffusers, Registers, and Grilles)
- 2. Flexible Diffusion Outlets

B. Related Sections:

- 1. Section 089000 "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
- 2. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

- 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
- 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected by architect.

C. Refer to Section 230500 "Common Work Results for HVAC."

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

- 1. Ceiling suspension assembly members.
- 2. Method of attaching hangers to building structure.
- 3. Size and location of initial access modules for acoustical tile.
- 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- 5. Duct access panels.

B. Source quality-control reports.

1.5 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."
- B. Conform to NFPA 90A "Standard for the Installation of Air-Conditioning and Ventilating Systems" and 90B "Standard for the Installation of Warm Air Heating and Air-Conditioning Systems".

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store and handle in strict compliance with manufacturer's written instructions and recommendations.
- B. Protect from damage due to weather, excessive temperature, and construction operations.

1.7 WARRANTY

- A. Manufacturer's Warranty: Provide manufacturer's standard limited warranty.

PART 2 - PRODUCTS

2.1 AIR DISTRIBUTION DEVICES (DIFFUSERS, REGISTERS, AND GRILLES)

- A. Furnish and install air distribution devices, mounted grilles, registers, diffusers, slot diffusers and bar diffusers as indicated on the Drawings.
 - 1. Provide with sponge rubber or soft felt gaskets.
 - 2. Provide mounting frames as required to accommodate the type of ceiling or surface in which the air distribution devices are to be mounted.
 - 3. The type, style, materials of construction, finish, face size, neck size, neck configuration, air pattern, and accessories shall be as indicated on the Drawings.
 - 4. Where called for on the Drawings, the grilles, registers and ceiling outlets shall be provided with deflecting devices and manual damper. These shall be the standard product of the manufacturer, subject to review by the Architect, and equal to brand scheduled.
- B. All nominal 24" x 24" ceiling diffusers shall be provided with R-6, factory installed, molded insulation blanket with foil skim kraft vapor barrier. Insulation shall be applied to the back (top) of the diffusers.
- C. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Krueger.
 - 2. METALAIRE, Inc.
 - 3. Nailor Industries Inc.
 - 4. Price Industries.
 - 5. Titus.
- D. 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.

2.2 FLEXIBLE DIFFUSION OUTLETS

A. Continuous Tubular Diffuser:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. DuctSox Corp.
 - b. Patron Products Inc.
2. Duct Connection: Round.
3. Accessories:
 - a. Quick-connect joint.
 - b. Snap hooks.
 - c. Cleanout zipper.
 - d. Condensate drain.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions, approved submittals and in proper relationship with adjacent construction.
- B. Install diffusers, registers, and grilles level and plumb.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
- D. Ceiling-Mounted Outlets and Inlets:
 1. Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
 2. Independently support diffusers and grilles for T-bar mounting that exceed weight limit of ceiling suspension system in which they are to be installed.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

3.4 CLEANING AND PROTECTION

- A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean products in accordance with manufacturer's recommendations to remove burrs, dirt, and smudges.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."
- B. Coordinate sizes and locations of equipment supports with actual equipment provided.

1.8 WARRANTY

- A. 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. The 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. The warranty excludes parts associated with routine maintenance, such as belts and air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or Engineer approved equal.

2.2 AIR HANDLING UNITS

- A. General Description
 1. Indoor air handling units shall include filters, supply fans, DX evaporator coil, reheat coil, electric heaters, mixing box, and unit controls.
 2. Unit shall have a draw-through supply fan configuration and discharge air horizontally.
 3. The unit shall be factory assembled and tested including leak testing of the coils and run testing of the supply fans and factory wired electrical system. Run test report shall be supplied with the unit.
 4. Unit shall have decals and tags to indicate lifting and rigging, service areas, and caution areas for safety and to assist service personnel.
 5. Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.
 6. Installation, Operation and Maintenance manual shall be supplied within the unit.

7. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's access door.
8. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.

B. Construction:

1. All cabinet walls and access doors shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
2. Unit insulation shall have a minimum thermal resistance R-value of 6.25. Foam insulation shall have a density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929-11 for a minimum flash ignition temperature of 610°F.
3. 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.
4. The 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 conduits through cabinet panels shall include sealing to reduce air leakage.
5. Access to filters, cooling coil, reheat coil, heating coil, supply fans and electrical and controls components shall be through hinged service access doors.
6. Access doors shall be flush mounted to cabinetry. Coil access door and supply fan access door shall include quarter-turn lockable handles. Supply fan access door shall include removable pin hinges.
7. Units with cooling coils shall include sloped 304 stainless steel drain pan. Drain pan connection shall be on left hand or right hand (see plans) side of the unit.
8. Cooling coils shall be mechanically supported above the drain pan by multiple supports that allow drain pan cleaning and coil removal.

C. Electrical:

1. Unit shall be provided with an external control panel with separate low voltage control wiring with conduit and high voltage power wiring with conduit between the control panel and the unit. The control panel shall be field mounted.
2. Unit shall be provided with standard power block for connecting power to the unit.
3. Unit shall include a factory installed 24V control circuit transformer.
4. Unit shall be provided with phase and brownout protection which shuts down all electrical components in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.

D. Supply Fans:

1. The unit shall include direct drive unhooded, backward curved, plenum supply fans.
2. Motor shall be a high efficiency electronically commutated motor.
3. Blower and motor assembly shall be dynamically balanced.
4. Blower and motor assembly shall be isolated with neoprene gasket.

- E. Cooling Coil:
1. Evaporator Coil
 - a. Coil shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
 - b. Coil with two circuits shall have interlaced circuitry.
 - c. Coil shall have 6 rows and 12 fins per inch.
 - d. Coil shall be hydrogen or helium leak tested.
 - e. Coil shall be furnished with a factory installed thermostatic expansion valves. The sensing bulbs shall be field installed on the suction line immediately outside the cabinet.
 - f. Coil shall have left or right-hand external piping connections (see plans). 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. Refrigeration System:
1. Air handling unit and matching condensing unit shall be capable of operation as an R-454B split system air conditioner.
 2. Each refrigeration circuit shall be equipped with thermostatic expansion valve type refrigerant flow control.
 3. Modulating hot gas reheat shall be provided on the lead refrigeration circuit. Refrigeration circuits shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a dehumidification control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space. Modulating reheat valves shall be factory installed in the matching AAON condensing unit. Reheat line connections shall be labeled, extend beyond the unit casing and be located near the suction and liquid line connections for ease of field connection. Connections shall be factory sealed on both the interior and exterior of the unit casing to minimize air leakage.
- G. Filters:
Options
1. Unit shall include 2 inch thick, pleated panel filters with an ASHRAE efficiency of 30% and MERV rating of 8, upstream of the cooling coil.
 2. Unit shall include a clogged filter switch.
- H. Controls:
1. Unit shall be provided with an external control panel with separate low voltage control wiring with conduit and high voltage power wiring with conduit between the control panel and the unit. The control panel shall be field mounted.
Factory Installed and Factory Provided Controller
 - a. Unit controllers shall be capable of controlling all features and options of the unit. The controller shall be factory installed in the unit controls compartment and factory tested.
 - b. Controller shall be capable of standalone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
 - c. The controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
 - d. Controller shall include non-volatile memory to retain all programmed values, without the use of an external battery, in the event of a power failure.

- e. Constant Volume Controller
 1. The unit shall modulate cooling with constant airflow to meet space temperature cooling loads.
 2. With modulating hot gas reheat, the unit shall modulate cooling and hot gas reheat as efficiently as possible, to meet space humidity loads and prevent supply air temperature swings and overcooling of the space.
 3. Unit shall modulate heating with constant airflow to meet space temperature heating loads. With staged heating, capacity shall modulate based on space temperature. With modulating heating, capacity shall modulate based on supply air temperature.
 4. Outside air temperature sensor, supply air temperature sensor and space temperature sensor with temperature setpoint reset and unoccupied override shall be furnished with the unit for field installation.
 5. With the modulating hot gas reheat option a space humidity sensor and supply air temperature sensor shall be furnished with the unit for field installation. Suction pressure sensor shall be factory installed. Supply air temperature and space humidity setpoints, for the dehumidification mode of operation, shall be adjustable.
2. Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software. Controller shall be capable of connecting with other factory installed and factory provided unit controllers with individual unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable. Controller shall be capable of communicating and integrating with a LonWorks or BACnet network.

2.3 Condensing Units

A. General Description

1. The condensing unit shall include compressors, air-cooled condenser coils, condenser fans, suction and liquid connection valves, and unit controls.
2. Condenser shall include air-cooled condenser coils, condenser fans, discharge and liquid connection valves, and unit controls.
3. The 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 controls compartment's literature pocket.
4. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and assist service personnel.
5. Unit components shall be labeled, including split system piping stub outs, refrigeration system components and electrical and controls components.
6. Installation, Operation and Maintenance manual shall be supplied within the unit.
7. Laminated color-coded wiring diagrams shall match factory installed wiring and be affixed to the interior of the control compartment's access door.
8. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.

B. Construction

1. The unit shall be completely factory assembled, piped, wired and shipped in one section.
2. The unit shall be specifically designed for outdoor applications.

3. Access to compressors and controls components shall be through hinged access doors with quarter turn, lockable handles.
 4. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
 5. Unit shall include lifting lugs.
- C. Electrical
1. Unit shall be provided with standard power block for connecting power to the unit.
 2. Control circuit transformers and wiring shall provide 24 VAC control voltage from the line voltage provided to the unit.
 3. Air-source heat pump shall include an optimized start defrost cycle to prevent frost accumulation on the outdoor coil during heat pump heating operation and to minimize defrost cycle energy usage. If the temperature of the outdoor heat exchanger and/or the suction line is less than a predetermined value, a deferred defrost cycle is initiated wherein the defrost cycle starts after a variable, continuously optimizing, time interval has elapsed. The defrost cycle is terminated when the relative temperatures of the outdoor heat exchanger and/or the suction line indicate that sufficient frost is melted from the heat exchanger to ensure adequate time between successive defrost cycles for optimizing the efficiency and reliability of the system, or after a predetermined time interval has elapsed, whichever condition occurs first. During the defrost cycle all compressors shall energize, reversing valves shall energize, and auxiliary heat shall de-energize.
 4. The unit shall be provided with a factory installed and factory wired, non-fused disconnect switch.
 5. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more that 10% under design voltage, or on phase reversal.
- D. Refrigeration System
1. Compressors shall be R-454B scroll type with thermal overload protection, individually or tandem circuit. Each compressor should be furnished with a crank-case heater.
 2. 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.
 3. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of sound from the compressors into the building area.
 4. 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. Finished field installed refrigerant circuits shall include the low side cooling components, refrigerant, thermal expansion valve, liquid line (insulated hot gas bypass line) (insulated hot gas line) and insulated suction line.
 5. Unit shall include a factory holding charge of R-454B refrigerant and oil.
 6. Lead refrigeration circuits shall include a 10-100% variable capacity compressor.
 7. Lead refrigeration circuits shall be provided with hot gas reheat coil in the matching air handler, modulating valves, electronic controller, supply air temperature sensor and a dehumidification control signal terminal which allows the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.

8. Unit shall be configured as an air-source heat pump. Each refrigeration circuit shall each be equipped with a liquid line filter drier with check valve, reversing valve, accumulator, and thermal expansion valves on both the indoor and outdoor coils. Reversing valves shall de-energize during the heat pump heating mode of operation.
9. Electronically commutated motor driven variable speed condenser fans shall be provided for head pressure control and allow operation down to 25°F.
10. Each refrigeration circuit shall be equipped with a liquid line sight glass.
11. Each refrigeration circuit shall be equipped with suction and discharge compressor isolation valves.

E. Condensers

1. Air-Cooled Condenser

- a. Condenser fans shall be axial flow, direct drive fans.
- b. Fan motor shall be direct drive ECM controlled via condenser head pressure.
- c. Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum (copper) fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
- d. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
- e. Coils shall be hydrogen or helium leak tested.

F. Controls

1. Standard Terminal Block

- a. Unit shall be provided with a terminal block for field installation of controls. Option shall include factory installed isolation relays

2.4 CAPACITIES AND CHARACTERISTICS

- A. Refer to Schedule on Plans.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Retain one of first two paragraphs below for ground-mounted units.
- D. Install ground-mounted, compressor-condenser components on 4-inch- (100-mm-) thick, reinforced concrete base that is 4 inches (100 mm) larger, on each side, than unit. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.
- E. Install roof-mounted compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to support removable, cadmium-plated fasteners.

- F. Retain the first paragraph below if Project is in a seismic area.
- G. Install seismic restraints.
- H. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of [1 inch (25 mm)] <Insert static deflection>. See Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- I. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 - 1. Water Coil Connections: Comply with requirements specified in Section 232113 "Hydronic Piping." Connect hydronic piping to supply and return coil connections with shut off-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.
 - 2. Retain subparagraph below for units with remote water-cooled condenser.
 - 3. Remote, Water-Cooled Condenser Connections: Comply with requirements specified in Section 232113 "Hydronic Piping." Connect hydronic piping to supply and return connections with shut off-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.
- B. Where piping is installed adjacent to the unit, allow space for service and maintenance of unit.
- C. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply [and return] ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3. Test and adjust controls and safeties. Replace damage and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

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

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train] Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

DIVISION 26

Electrical

95% Construction Documents

SECTION 260001 - BASIC REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Drawings and Specifications
 - 1. Division 26 specifications are written in imperative and streamlined format. This imperative language is directed to the Contractor. The word "shall be" shall be included by inference where a colon (:) is used within sentences and phrases.
- C. Codes, Permits and Standards
 - 1. Comply with the most recently revised versions of applicable laws, rules, regulations, and ordinances of federal, state, and local utilities and authorities.
 - 2. Obtain all applicable permits, licenses and inspections and pay all fees charged by above authorities.
 - 3. Work shall comply with the local city codes and ordinances, the regulations of state authorities having lawful jurisdiction and the codes, statues and reference standards identified within these Specifications. 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.
 - 4. Where alterations to and deviations from the Contract Documents are required to comply with interpretations of a Code Authority Having Jurisdiction (AHJ), report the requirements and secure approval before starting work. Contractor shall review any requested modifications with the Engineer and secure his approval before proceeding.
 - 5. Where Contract Document requirements are in excess of Code requirements and are permitted under the Code, the Contract Documents shall govern.

1.2 DEFINITIONS & ABBREVIATIONS

- A. Definitions
 - 1. Contract Documents - Drawings and the project manual, including Specifications.
 - 2. Install: to set in place in position for service.
 - 3. Furnish: to supply.
 - 4. Provide: to install and furnish.
 - 5. City - When used in an otherwise non-specific reference anywhere in the Contract documents, City is defined to refer to the local municipal authority governing the project address or the City who's ETJ includes the project address.
- B. Abbreviations
 - 1. ANSI American National Standards Institute.
 - 2. ASHRAE American Society of Heating, Refrigerating & Air-Conditioning Engineers
 - 3. EIA Electronic Industry Association.
 - 4. ETL Electrical Testing Laboratory.
 - 5. ETJ Extra-Territorial Jurisdiction

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| 6. | FM | Factory Mutual |
| 7. | IEEE | Institute of Electrical and Electronics Engineers |
| 8. | IES | Illuminating Engineering Society of North America |
| 9. | LPI | Lightning Protection Institute. |
| 10. | NFPA | National Fire Protection Association |
| 11. | NEC | National Electric Code (NFPA-70) |
| 12. | NESC | National Electric Safety Code |
| 13. | NECA | National Electrical Contractor's Association |
| 14. | NEMA | National Electrical Manufacturers Association |
| 15. | NETA | InterNational Electrical Testing Association |
| 16. | NRTL | Nationally Recognized Testing Laboratory |
| 17. | OSHA | Occupational Safety Health Administration (US Department of Labor) |
| 18. | UL | Underwriters Laboratories |

1.3 SUMMARY ORGANIZATION

- A. PART 1 of This Section Includes:
1. Electrical Utilities and Service
 2. Electrical equipment coordination and installation.
 3. Submittal requirements.
- B. PART 2 of This Section Includes:
1. Substitution requirements.
- C. PART 3 of This Section Includes:
1. Common Requirements for Electrical Installation
 2. Electric wiring of motors and equipment
 3. Vibration Isolation
 4. Quality Assurance requirements.

1.4 ELECTRIC UTILITIES AND SERVICE

- A. Utilities: The Contract Documents reflect the general location and routing of utilities required for this project. Visit the site, and coordinate and confirm the exact requirements for electrical services. Refer to Division 01. [Electrical and utilities and service entrance equipment exist at the site and shall remain as installed].
1. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - a. Notify the Owner's representative no fewer than (fourteen) (14) days in advance of proposed interruption of electric service.
 - b. Indicate method of providing temporary electric service.
 - c. Do not proceed with interruption of electric service without the Owner's representative's written permission.]
 2. Temporary Services:
 - a. Provide temporary electrical service and electric power distribution and temporary lighting throughout the construction site. Install and maintain in accordance with National Electrical

Code and OSHA requirements. Make arrangements with the serving utility for point of service for temporary electric service and pay costs for delivery to and use at the site.

- b. Existing electrical distributions systems at the site may be utilized for temporary construction power. Submit to the Owner in writing, documents identifying the locations and anticipated maximum demand at which power will be utilized, and obtain the Owner's approval, in writing, prior to connection and utilization.

1.5 ELECTRICAL EQUIPMENT COORDINATION AND INSTALLATION

- A. General: Refer to Division 1 for general coordination requirements applicable to the entire work. 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. All major feeders 1-1/2" diameter and over shall be shown on site and floor plans.
 1. Arrange electrical work in a neat, plumb and straight 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. Maintain 4" clearance of other systems and 12" above ceiling.
 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 with approval from Author by having jurisdiction.
- B. Pre-installation planning: Coordinate arrangement, mounting, and support of electrical equipment as follows:
 1. Allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 2. Provide access for disconnecting means and working space for equipment with minimum interference to adjacent equipment.
 3. The equipment shall be arranged to facilitate service, maintenance, and repair or replacement of components and equipment.
 4. Electrical equipment shall not be installed below piping or ductwork.

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 hierarchy of precedence shall, in general, be observed:
 - a. Building lines
 - b. Structural members
 - c. Piping and ductwork installed at required slope.
 - d. Busway
 - e. Supply Ductwork
 - f. Exhaust Ductwork
 - g. Cable Tray
 - h. Chilled water and heating hot water piping
 - i. Domestic water piping
 - j. Feeder conduit
 - k. Branch conduit
 - l. Cabling not installed in raceway or cable trays
6. Coordination submittal requirements
 - a. Provide electrical room layouts, scaled to $1/4" = 1' - 0"$ for all rooms or spaces containing electrical distribution equipment. These shall be provided with the associated electrical distribution equipment submittals.
 - b. Floor plans shall show dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

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 to approximate scale with intent to depict how these items shall be integrated into the building. Locate all items by field 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 diagrammatic locations 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 specifications 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. Undocumented statements will not 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 for completion of the project.

1.8 SUBMITTAL REQUIREMENTS

- A. Provide all electrical shop drawing submittals at the same time.
- B. Submittals shall be provided in binders and arranged in sequence by Specification section number. Provide submittals only for specification sections that list this requirement.
 1. Provide tabs for each section, labeled to match the associated specification. The page after each tab section shall contain a typed list of any exceptions that the Contractor is proposing.
 2. Each page of the submittal shall be a clear copy or scan, indicating items and options proposed for use in the project with a graphical arrow. Items included on a submittal page that are not proposed for use shall be deleted with strike-through or other acceptable method that clearly distinguishes the proposed from non-relevant information.

- C. Subject to the requirements in Division 1, at the Contractor's option, submittals may be provided in PDF form.
 - 1. All format and informational requirements for submittals in binders apply to PDF submittals.
 - 2. Multiple files may be submitted, however, these must be organized into a consistent format.
 - 3. PDF submittal shall include a table of contents with page numbers listed for the beginning of each section.
 - 4. Additionally, the PDF shall be formatted to include tab or chapter shortcuts, labeled with the associated specification section. These shortcuts shall allow the reader to jump to a tab or chapter associated with beginning of each specification section with a single action.
 - 5. At engineer's request, the contractor shall submit hard copy version in accordance with requirements outlined above.

- D. Provide closeout submittals for all products used. Refer to related specification section for additional requirements.
 - 1. Provide maintenance and warranty information with contact information for parts and service of equipment.

PART 2 - PRODUCTS

2.1 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS

- A. Materials and equipment shall be new, of best grade and quality, and meet all requirements of the Contract Documents. Materials and equipment shall conform to National Electrical Code requirements and shall be listed by Underwriters Laboratories, Inc. (UL). UL listing will be accepted as evidence that the material or equipment conform to the standards of that agency. In lieu of this listing, submit a statement from a nationally recognized testing agency, indicating that products have been tested in accordance with UL criteria and that the materials and equipment comply with Contract requirements.

- B. Materials and equipment shall be standard catalog products of manufacturers regularly engaged in the manufacture of products conforming to these Specifications. Custom fabricated items shall be fully described using Drawings and technical data sufficient to demonstrate compliance with the Contract Documents.

2.2 SUBSTITUTIONS

- A. Basis of Design - For products specified in part 2.1 of the associated specification section, as "Basis of Design", that term is herein defined as the standard level of product that is required for the project.
 - 1. The use of term Basis of Design in these specifications is intended to allow the Contractor to propose use of non-specified manufacturer's products, provided that the proposed substitute is of equal or greater construction material, workmanship, quality, performance, and manufacturer support. If the product's proposed location is not concealed, aesthetic considerations are also considered as a significant factor.
 - 2. During the bid process, the Engineer will not evaluate products and provide approval prior to the bid date on proposed substitute products. If the Contractor wishes to propose substitutions, the Engineer will evaluate the successful Contractor's proposed alternates during the submittal review process. The Engineer will take no exception to the use of individual products determined to be equal. That decision may be the result of consultation and input from other members of the design team. If a product is not determined to be equal, it will be rejected and another product that is equal to the basis of design shall be re-submitted by the Contractor. The Engineer will not evaluate

more than two substitution attempts before the Contractor is required to submit the specified product.

3. If the Contractor proposes product substitutions that may not be equal to the specified product, and cost savings are associated with the use of the proposed substitute, then the Contractor should propose these as part of a VE (Value Engineering) process, with line item cost savings identified for each product substitution proposed. With information on line item costs, the design team may determine if the proposed substitutes, though not equal, represent a better value and these *may* be recommended for use.
- B. Substitutions are generally not allowed for products specified in the associated specification section when listed as "Provide products by one of the following". If there is a concern about delivery schedules from the manufacturers listed or other factors, these special case substitutions will be considered individually during the submittal phase.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. 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, state licensed workmen, presenting a neat appearance when completed, straight and plumb.
- B. 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.

3.2 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 and comply with code.
- 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: Space requirements and equipment arrangement may vary for each manufacturer, the responsibility for ensuring initial access and suitability rests with the Contractor.
- E. Review: Final arrangements of equipment to be installed shall be subject to the Architect's review.

3.3 SAFETY REGULATIONS

- A. All electrical work, including work associated with temporary power, 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.

3.4 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 safeguards as required to properly protect equipment from corrosion, drip, humidity, dust, and 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 equipment 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. Contractor shall support equipment above floor slab and provide suitable, protective covering.
- D. Install in accordance with approved, equipment submittal layouts.
- E. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- F. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames." Coordinate location of access panels and doors with Architect prior to the associated equipment rough-in.
- G. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".
- H. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.5 ELECTRIC WIRING OF MOTORS AND EQUIPMENT

- A. The work of Division 26 includes:
 - 1. Installation and power wiring of individually mounted motor controllers furnished under other Divisions.
 - 2. Power wiring for individually mounted and group mounted motor controllers furnished and installed under Division 26.
 - 3. Power wiring of motor controllers provided integral with equipment furnished under Division 26 and other Divisions.
 - 4. Power and control wiring, of any voltage, of systems specified in Division 26.
- B. The work of Division 26 does not include:
 - 1. Control wiring associated with HVAC/EMCS control systems, including that which interfaces with fire detection and alarm systems, and motor control.

2. Remote control devices associated with HVAC/EMCS controller systems which interface with and execute control of motor control equipment.

3.6 VIBRATION ISOLATION

- 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.
- B. Provide vibration isolation means for equipment and materials to prevent the transmission of perceptible vibration, structure borne or air borne noise. Items requiring vibration isolation include:
 1. Switchgear, motor control centers, motor starter panelboards, motors, transformers and rotating and reciprocating equipment shall be mounted on cork, rubber or steel spring isolator units properly sized, spaced and loaded as recommended by manufacturer.
 2. Electrical Conduit: Isolate from dry type transformers, rotating and reciprocating machinery using flexible conduit, 18" minimum length or 12" of flexible conduit per 1" of conduit diameter with maximum of 36".

3.7 QUALITY ASSURANCE TESTING

- A. Description of Work
 1. General: Provide testing of electrical work installed under Divisions 26, 27 and 28, 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.
- B. Personnel
 1. Personnel: Submit evidence to show that the personnel who will actually test the systems are qualified and state certified.
 2. The Engineer/Owner 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.
- C. Submittals
 1. Testing Procedures: Submit four copies of all proposed testing procedures to the Engineer for review at least 30 days prior to conducting any testing.
 2. 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.
 3. Test Data and Results: Submit four copies of complete data and certified test results for each test performed, including, but not limited to:
 - a. Test performed.
 - b. Test procedure.
 - c. System and area tested.
 - d. Date(s) and time(s) of test.
 - e. Weather conditions.
 - f. Test criteria.
 - g. Test results.

- h. Additional pertinent information.
 - 4. 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.
 - 5. 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.
 - 6. 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 and currently calibrated.
 - 7. Prepare test and inspection reports, including a certified report that identifies electrical distribution equipment included and that describes scan results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
 - 8. Test Log: The Contractor shall maintain a test log at the site to document the results of all successful and unsuccessful testing 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 and Owner's Representative prior to the Substantial Completion inspection. A space shall be provided on the test log for signoff by the Owner's Representative.
- D. Notice
- 1. General: Notify the Engineer and the Owner's Representative in writing two weeks prior all scheduled testing to allow time for scheduling witness of testing, where elected by the Engineer and Owner's Representative.
- E. Materials
- 1. General: Provide all materials and test equipment required for testing of specified electrical systems, including retesting until acceptable test results are obtained.
- F. Manufacturer's Field Service
- 1. Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.
- G. Preparation
- 1. Perform visual mechanical inspection and electrical tests for field connections Test insulation resistance for each electrical distribution equipment bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- H. Testing
- 1. 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.

2. Tests: Refer to the Table below for inspection and testing requirements associated with listed product specification sections:

Spec Section #	Title								Notes
260519	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES	○		○	○				
260526	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS	○	○	○				○	
260926	LIGHTING CONTROL PANELBOARDS	○	○	○	○	○			
262300	LOW-VOLTAGE SWITCHGEAR	○	○	○	○	○			
262413	SWITCHBOARDS	○	○	○	○	○			
262416	PANELBOARDS	○	○	○	○	○			
262600	POWER DISTRIBUTION UNITS								a
262913	ENCLOSED CONTROLLERS	○	○	○	○	○			
262923	VARIABLE FREQUENCY MOTOR CONTROLLERS								a
263213	ENGINE GENERATORS	○	○	○					a
263600	TRANSFER SWITCHES								a

NOTES:

- a. Refer to individual specification section for additional testing requirements

I. THERMOGRAPHIC TESTING:

1. Provide a thermographic scan to measure equipment temperature and detect significant deviations from normal values.
2. Conduct a thermographic test of the main switchboards/switchgear, unit substations distribution panels, panelboards, automatic transfer switches, busway joints, motor control centers and other electrical distribution apparatus and connections using an infrared temperature scanning unit. The test shall be performed by an independent testing laboratory. Connections that are indicating higher temperature levels than acceptable shall be tightened, lugs replaced and/or OCPD replaced as required to eliminate the condition. Conduct test, using test reporting forms, between 6 and 8 months after beneficial occupancy, but in no case beyond the warranty period. Correct unacceptable conditions prior to end of the warranty period.
3. Prepare test and inspection reports, including a certified report that identifies electrical distribution equipment included with description of scan results. Provide calibration record for device. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

J. RESULTS AND DEFICIENCY CORRECTIONS:

1. Correct malfunctions on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
2. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
3. Any resultant delay as a result of such necessary retest, does not relieve the Contractor of his responsibility under this contract.
4. Equipment will be considered defective if it does not pass tests and inspections. Tested products which fail to provide acceptable test results shall be repaired or replaced with suitable materials as required to obtain acceptable test results.

3.8 CONTRACTOR WARRANTIES AND GUARANTEES

- A. General: Contractor shall guarantee all material and equipment installed by him against defects in workmanship and material for a period of 24 months after final acceptance of the work by the Owner and he shall repair or replace any materials or equipment developing such defects within that time, promptly on due notice given him by the Owner and at Contractor's sole cost and expense.
- B. Equipment: All equipment bearing a manufacturer's guarantee in excess of the time requirement above, such as electrical equipment, devices, components, and similar items, shall be considered to have that guarantee extended directly to the Owner by the manufacturer. Any such equipment that proves defective in materials or workmanship within the guarantee period is to be corrected 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 two complete years after date of final acceptance of the work by the Owner, at Contractor's sole cost and expense.

END OF SECTION

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.
- C. MC: Metal Clad Cable, Type MC, Reference NEC Article 330

1.4 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.
- B. Closeout Submittal
 - 1. Include final version of approved shop drawing submittals within the Operation and Maintenance manual.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. General Cable Corporation
 - 2. Senator Wire & Cable Company
 - 3. Southwire Company
 - 4. Cerrowire

5. Philatron

- B. Copper Conductors: Comply with NEMA WC 70.
- C. Conductor Insulation: Comply with NEMA WC 70 for Types THW, THHN-THWN and XHHW.
- D. Multi-conductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC with ground wire.

2.2 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; EGS Electrical Group LLC.
 - 4. 3M; Electrical Products Division.
 - 5. TE Connectivity
 - 6. Polaris Electrical Connectors
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway or Type XHHW, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- E. Feeders Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.
- F. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions:
 - 1. Type THHN-THWN, single conductors in raceway.

2. Where otherwise allowed in the Construction Documents and NEC, MC cable may be used, subject to constraints listed in 3.3, H., hereinbelow.
- H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- J. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- K. Class 2 Control Circuits: Type THHN-THWN, in raceway or Power-limited cable, concealed in building finishes.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- F. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- G. Provide support for conductors in vertical raceways in accordance with NEC 300.19. Refer to Table 300.19(A) for support spacing distance requirements of specific cable sizes.
- H. The use of Metal-Clad (MC) cable is prohibited except as follows:
 1. Limit the use of Type MC cable to single-phase branch circuits in interior dry locations, supplying wall mounted devices.
 2. Conceal Type MC cable above accessible ceilings, in drywall partitions, and in equipment enclosures.
 3. No run of Type MC cable shall exceed 25'-0".
 4. Do not run Type MC cable horizontally in walls.
 5. Do not run Type MC cable directly into surface-mounted panels, cabinets or other equipment from switches or other devices.
 6. Use of Type MC Cable for Receptacle Circuits
 - a. Conduit between the panelboard and junction box and between junction boxes above the accessible ceiling in the room or space in which the receptacles are located shall be rigid metal conduit (RMC), intermediate metal conduit (IMC), or EMT. Type MC cable is not permitted for this application.
 - b. No more than three (3) single-phase receptacle circuits shall be permitted in a single conduit for installations above the ceiling
 7. Use of Type MC Cable for Lighting Circuits:

- a. Conduit between the panelboard and junction box above the accessible ceiling in the room or space in which the lighting fixtures are located shall be RMC, IMC, or EMT. Type MC cable is not permitted for this application.
 - b. The Owner's Field Inspector may provide different direction or requirements to the contractor depending on actual field conditions or other considerations.
 - c. Type MC cable may be run vertically in the wall for a length not to exceed 25'-0" between a junction box above the ceiling and each light switch.
 - d. Type MC cable runs between a junction box above the ceiling and a lighting fixture shall not exceed 6'-0".
8. Prior to installation, the contractor shall submit to Engineer/Owner for review a plan or sketch of each space or room identifying where the use of type MC cable is proposed and how it is to be supported. MC cable shall be prohibited in these types of spaces if the ceilings are not accessible. Specify the length for each run of type mc cable on the plan or sketch.
9. Material for MC Cabling
- a. Type MC cable and connectors shall be UL 1569 listed.
 - b. 600V THHN/THWN-insulated solid copper circuit conductors with an insulated copper equipment grounding conductor.
 - c. Minimum conductor size #12 AWG; provide larger conductors as required to limit voltage drop 3 percent at full connected load and to adjust allowable ampacity if there are more than 3 current-carrying conductors in a cable.
 - d. Conductor color code: Refer to Owner's Design Guidelines, "Low-Voltage Conductors."
 - e. Listed insulated-throat or insulating-bushing connectors.
10. Installation
- a. Install Type MC cable according to NECA 120, Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC) (ANSI).
 - b. Use listed spring steel Type MC cable supports or plastic tie wraps to support Type MC cables; do not use tie wire to support Type MC cables.

3.4 WIRING APPLICATION, SIZE AND DERATION

A. General –

1. Provide individual neutrals for each branch circuit phase.
 2. Provide conductor size equal or greater than as specified on the drawings. Where not specifically shown, minimum wire size shall be #10AWG copper for homeruns and #12 AWG copper for 20A branch circuits.
- B. Apply ambient temperature deration factors per NEC 310.15 (B).
- C. Apply adjustment factors for more than three current carrying conductors, where applicable, per NEC 310.15 (C). Homeruns shall not contain more than three branch circuits.
- D. Unless specifically indicated on the drawings, conduits containing multiple homerun circuits to serve a wireway downstream of a panelboard is not allowed.

3.5 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings.

- C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.

END OF SECTION

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

- A. Section includes general requirements for grounding and bonding of electrical installations, systems, and equipment.

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 grounding system diagram for special grounding systems.
 - 2. Cut sheets of grounding products.
- B. Closeout Submittal
 - 1. Include final version of approved shop drawing submittals within the Operation and Maintenance manual.

1.4 INFORMATIONAL SUBMITTALS

- A. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
 - 1. Test wells.
 - 2. Ground rods.
 - 3. Ground rings.
 - 4. Grounding arrangements and connections for separately derived systems.
 - 5. Grounding for sensitive electronic equipment.
- B. Qualification Data: For qualified testing agency and testing agency's field supervisor.]
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.]
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
- C. Bare Grounding Conductor and Conductor Protector for Wood Poles:
 - 1. No. 4 AWG minimum, soft-drawn copper.
 - 2. Conductor Protector: Half-round PVC or wood molding; if wood, use pressure-treated fir, cypress, or cedar.
- D. Grounding Bus: Provide grounding busbars of size indicated on drawings. If not indicated, provide a pre-drilled, rectangular bar of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5,000 V.

2.2 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel 3/4 inch by 10 feet (19 mm by 3 m) in diameter.
- B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with non-hazardous, electrolytic chemical salts.
 - 1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
 - 2. Backfill Material: Electrode manufacturer's recommended material.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least 24 inches (600 mm) below grade.
 - 2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.
- E. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING OVERHEAD LINES

- A. Comply with IEEE C2 grounding requirements.
- B. Install two parallel ground rods if resistance to ground by a single, ground-rod electrode exceeds 25 ohms.
- C. Drive ground rods until tops are 12 inches (300 mm) below finished grade in undisturbed earth.

- D. Ground-Rod Connections: Install bolted connectors for underground connections and connections to rods.
- E. Lightning Arrester Grounding Conductors: Separate from other grounding conductors.
- F. Secondary Neutral and Transformer Enclosure: Interconnect and connect to grounding conductor.
- G. Protect grounding conductors running on surface of wood poles with molding extended from grade level up to and through communication service and transformer spaces.]

3.3 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.]

3.4 EQUIPMENT GROUNDING

- A. Install bare grounding electrode conductors in raceway.
 - 1. Exterior applications – Raceways used for protection of the GEC in exterior applications shall be PVC SCH80.
 - 2. Provide bonding jumpers from the GEC to listed grounding fittings at each end of steel raceways, where used for protection of the GEC.
- B. Install insulated equipment grounding conductors with all feeders and branch circuits.
- C. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.

3. Receptacle circuits.
 4. Single-phase motor and appliance branch circuits.
 5. Three-phase motor and appliance branch circuits.
 6. Flexible raceway runs.
- D. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- E. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install an insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- F. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- G. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- H. Telecommunications Equipment: In addition to grounding and bonding required by NFPA 70, provide an infrastructure grounding system compliant with requirements of ANSI/TIA-607-B-2011. The system shall have the following components, as relevant to building layout:
1. TMGB - (Telecommunications Main Grounding Busbar), located in the MDF or Main Telecommunications Equipment Room and connected to the building's grounding electrode system by means of a minimum 3/0 BCT (Bonding Conductor for Telecommunications).
 2. TGB - (Telecommunications Grounding Busbar), located within each satellite Telecommunications Equipment Room or IDF, and connected to the TMGB via a TBB (Telecommunications Bonding Backbone). Provide TBB of the minimum size noted below unless larger size is indicated on the drawings.

TBB Conductor Length	TBB Minimum Size
Minimum	#4 AWG
21-26'	#3 AWG
27-33'	#2 AWG
34-41'	#1 AWG
42-52'	1/0
53-66'	2/0

67-84'	3/0
85-105'	4/0
Greater than 105'	250 kCM

3. GE - (Grounding Equalizer), provided between TGBs within satellite Telecommunications Equipment Rooms or IDFs at the top floor of multi-level buildings. The GE conductor shall be the same size as the largest TBB.
 4. TEBC - (Telecommunications Equipment Bonding Conductor). Provide minimum #6 AWG conductor servings as TEBC from each metallic enclosure or equipment rack to the MTGB or TGB. Terminate the TEBC on a grounding terminal.
- I. Provide a supplementary mesh-BN (Bonding Network) in Computer Rooms, bonded to each metallic support structure below the raised floor. The BN shall be connected to the TMGB via a TBB, sized at 3/0, unless otherwise indicated on the drawings.]
 - J. Poles Supporting Outdoor Lighting Fixtures: Install a # 4AWG bonding jumper from a ground terminal at each metallic pole or support arm to a grounding electrode. Reinforcing steel that is minimum 5/8" diameter and extends to 8' below final grade shall be permitted for use as the grounding electrode. Otherwise, provide a 5/8" x 8'-0" copper clad steel ground rod for use as the grounding electrode. The bonding jumper shall be routed within the pole base and insulated, if bonded to the reinforcing steel or installed within non-metallic conduit if bonded to a driven ground rod. Bond one imbedded bolt used for pole support to the reinforcing steel. These requirements are in addition to the equipment ground conductor installed in the same raceway as the branch-circuit conductors.

3.5 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.
 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 2. For grounding electrode system, install in accordance with details or description on drawing. If not otherwise indicated, provide at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.
 - 1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

3.6 LABELING

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer [and at the grounding electrode conductor where exposed].
 - 1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal[, at ground test wells] [, and at individual ground rods]. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: [10] <Insert value> ohms.
 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: [5] <Insert value> ohms.
 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: [3] <Insert value> ohms.
 4. Power Distribution Units or Panelboards Serving Electronic Equipment: [1] [3] <Insert value> ohm(s).
 5. Substations and Pad-Mounted Equipment: [5] <Insert value> ohms.
 6. Manhole Grounds: [10] <Insert value> ohms.
- F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.]

END OF SECTION

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
 - 1. Provide materials specified in the associated drawing details, where shown.

1.2 DESCRIPTION OF WORK

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
 - 2. Non-metallic slotted support systems.
- B. Shop Drawings
 - 1. Provide shop drawings for fabricated assemblies, if required by the associated detail or if the assembly's proposed dimensions, construction materials, or supplementary information is different than shown on drawings.

1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 3. Non-metallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 5. Channel Dimensions: Selected for applicable load criteria.
- B. Non-metallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. Fabco Plastics Wholesale Limited.
 - d. Seasafe, Inc.
 - 2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 - 3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
 - 4. Rated Strength: Selected to suit applicable load criteria.

- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 6. Toggle Bolts: All-steel, springhead type.
 - 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least **25** percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 - 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use minimum, 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete" or Section 033053 "Miscellaneous Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Comply with requirements in Section 099113 "Exterior Painting", Section 099123 "Interior Painting", and Section 099600 "High Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 260533 – RACEWAYS, WIREWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Products shall be designed, manufactured, tested, and installed in compliance with the associated section of the NEC.
- C. Products shall be used for purposes and installed in a manner consistent with the associated NRTL listing documentation.
- D. Coordinate installation with related requirements in specifications:
 - 1. Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling"
 - 2. Section 260553 "Identification for Electrical Systems"

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal conduits, tubing, and fittings.
 - 2. Nonmetal conduits, tubing, and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Surface raceways.
 - 5. Tele-Power Poles
 - 6. Boxes, enclosures, and cabinets.
 - 7. Handholes and boxes for exterior underground cabling.
 - 8. Manholes and Utility Structure accessories

1.3 DEFINITIONS & ABBREVIATIONS

- A. ARC: Aluminum rigid conduit.
- B. EMT ; Electrical Metallic Conduit
- C. FMC: Flexible Metallic Conduit. Comply with UL 1; zinc-coated steel.
- D. GRC, RGS: Galvanized rigid steel conduit. Comply with ANSI C80.1 and UL 6.
- E. IMC: Intermediate metal conduit. Comply with ANSI C80.6 and UL 1242.
- F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360
- G. RNC: Rigid Nonmetallic Conduit
- H. RTRC: Reinforced Thermosetting Resin Conduit Comply with UL 1684A and NEMA TC 14.

- I. ENT: Comply with NEMA TC 13 and UL 1653.
- J. RNC: Type EPC-40-PVC or EPC-80-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- K. LFNC: Comply with UL 1660.
- L. Rigid HDPE: Comply with UL 651A.
- M. Continuous HDPE: Comply with UL 651B.
- N. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.

1.4 SUBMITTALS

- A. Shop Drawing submittals shall include, but not be limited to, the following:
 - 1. Product Data:
 - a. Data sheets shall be submitted only for products intended to be used, with highlighted text used to identify specific products proposed. Information that does not apply to the project shall be omitted from the submittal or crossed out
 - 2. Shop Drawings:
 - a. Provide outlined, dimensioned drawings for custom enclosures and cabinets. Include proposed construction materials, plans, elevations, sections, and attachment details.
- B. Closeout Submittal
 - 1. Include final version of approved shop drawing submittals within the Operation and Maintenance manual.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Rigid Steel and Intermediate Metal Conduit:
 - a. Allied Tube & Conduit; a Tyco International Company.
 - b. Galvite/LTV Steel Tubular Products
 - c. Republic Conduit
 - d. Triangle PWC, Inc.
 - e. Youngstown Sheet & Tube.
 - f. Wheatland Tube Company; a division of Zekelman Industries.
 - 2. PVC-coated Rigid Steel:
 - a. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - b. Flexi-Guard, Inc.
 - c. Occidental Coating Company.
 - d. Perma-Cote.
 - e. Republic Conduit.
 - f. Robroy.
 - g. Triangle PWC, Inc.
 - h. Youngstown Sheet & Tube.

- i. Wheatland Tube Company; a division of Zekelman Industries.
 3. Electrical Metallic Tubing:
 - a. Allied Tube Conduit; a Tyco International Ltd. Co.
 - b. ETP Uni-Couple.
 - c. Republic Conduit.
 - d. Triangle PWC, Inc.
 - e. Youngstown Sheet & Tube.
 - f. Wheatland Tube Company; a division of Zekelman Industries.
 4. Flexible Metal and Liquidtight Flexible Metal:
 - a. AFC Cable Systems, Inc.
 - b. Alflex
 - c. Anaconda Metal Hose.
 - d. Electri-Flex Company.
 - e. Flexi-Guard, Inc.
 - f. Triangle PWC, Inc.
 - g. Wheatland Tube Company; a division of Zekelman Industries.
 5. Raceway Fittings:
 - a. Appleton Electric Company.
 - b. Crouse Hinds.
 - c. Efcor Division.
 - d. ETP-Uni-Couple.
 - e. O. Z/Gedney; a brand of EGS Electrical Group.
 - f. Raco, Inc.
 - g. Republic Conduit.
 - h. Steel City.
 - i. Thomas and Betts Corporation.
 - B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - C. 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 & conduit where required by NEC Article 250.
 - D. 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. Couplings and fittings shall be threaded Type UL 6/and UL1242 and ANSI C80.1 and C80.6, hot dipped galvanized steel. Split type couplings and fittings is not acceptable. IMC conduit shall not be used in sizes larger than 4 inch. Expansion fittings shall be OZ Type "DX", Appleton Type "XJ", Crouse-Hinds Type "XC" or an approved equal and shall have bonding jumpers. Cut ends shall be recoated with cold galvanized paint.

- E. PVC Externally-Coated Rigid Steel Conduit: Shall be ANSI C80.1 hot-dipped galvanized rigid steel conduit with an external 0.040 inch 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 inch minimum PVC coating to match the conduit.
- F. Electrical Metallic Tubing (EMT): Shall be UL 797 and ANSI C80.3 galvanized steel with plain ends.
 - 1. Fittings, couplings and connectors shall be UL 797 and ANSI C80.4 galvanized steel type.
 - 2. Fittings, couplings and connectors shall be all steel, compression type.
 - 3. All EMT connectors shall have insulated throats or bushings.
- G. Flexible Conduit:
 - 1. Flexible Metal Conduit: UL 1, zinc-coated steel
 - 2. Flexible Metal Conduit Fittings: UL 1, zinc-coated steel, insulated throat.
- H. Liquid-tight Flexible Metal Conduit: UL360 Liquid-tight flexible metal conduit with liquid-tight jacket of flexible polyvinyl chloride (PVC) or neoprene.
 - 1. Inner raceway shall be comprised of single strip, continuous, flexible, interlocked, double-wrapped [steel, galvanized inside and outside] [stainless steel] [aluminum]; forming a smooth internal wiring channel.
- I. Liquid-tight Flexible Metal Conduit Fittings: UL 1, liquid-tight, zinc-coated steel, neoprene gaskets and O rings, insulated throat.
- J. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Rigid Nonmetallic Conduit and Inner Duct:
 - a. Carlon.
 - b. Cantex, Inc.
 - c. Triangle PWC, Inc.
 - 2. Raceway Fittings:
 - a. Cantex, Inc. (PVC).
 - b. Carlon (PVC).
- B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Nonmetallic Conduit and Fittings:
 - 1. Schedule 40 Rigid PVC Conduit: Per UL 651, and NEMA TC 2, 90oC conductor temperature rating, only encased in concrete duct bank.
 - 2. Schedule 80 Rigid PVC Conduit: Per UL 651 and NEMA TC 2, 90oC conductor temperature rating not encased in concrete duct bank.
- D. PVC Conduit Fittings: Per NEMA TC 3 and compatible with PVC conduit system.

- E. Duct Bank Spacers: Spacers shall be interlocking plastic designed for the conduit sizes and nominal 3 inch spacing being used.
- F. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- G. Fittings for LFNC: Comply with UL 514B.
- H. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- I. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following manufacturers:
 - 1. Gutters and Wireways:
 - 2. ABB.
 - 3. Hoffman Manufacturing Company.
 - 4. Square D Company.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, with NEMA enclosure type as indicated on drawings. Where NEMA enclosure rating not indicated on drawings, provide the enclosure rating that meets or exceeds Code requirements and environmental exposure. Dimensional size shall exceed minimum requirements of NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following manufacturers:
 - a. Mono-Systems, Inc.
 - b. Panduit Corp.
 - c. Wiremold / Legrand.

- C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors, unless otherwise noted. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following manufacturers:
 - a. Hubbell Incorporated; Wiring Device-Kellems Division.
 - b. Mono-Systems, Inc.
 - c. Panduit Corp.
 - d. Wiremold / Legrand.

2.5 TELE_POWER POLES:

- A. Manufactures: Subject to compliance with requirements, provide products by the following manufactures:
 - 1. Mono-Systems, Inc.
 - 2. Panduit Corp
 - 3. Wiremold / Legrand
- B. Material and finish shall be as noted on drawings.
- C. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following manufacturers:
 - 1. Interior Outlet Boxes:
 - a. Appleton Electric Company.
 - b. Bowers.
 - c. O. Z./Gedney.
 - d. National Electric Products Company.
 - e. Raco; Hubbell
 - f. Star Sheet Metal.
 - g. Steel City; ABB Group.
 - 2. Weatherproof Outlet Boxes:
 - a. Appleton Electric Company.
 - b. Crouse-Hinds Company.
 - c. Raco; Hubbell, Inc.
 - d. Pyle-National Company.
 - e. Red Dot.
 - 3. Junction and Pull Boxes:
 - a. Appleton Electric Company.
 - b. Arrow-Hart, Inc.
 - c. O. Z. Gedney Company.
 - d. Hoffman Engineering Company.
 - e. Keystone Columbia, Inc.
 - f. Square D Company.

- d. Masonry Walls: Galvanized switch boxes made especially for masonry installations; depths of boxes must be properly coordinated for each specific installation.
 - e. 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.
 - f. Return Air Ceiling Plenum Boxes: In return air ceiling plenums, where 1/2 inch and 3/4 inch conduits are employed, 4 inches square by 2 1/8 inches deep plenum boxes shall be used.
 - g. Surface: Type "FS" or Type "FD" box with surface cover.
 - h. Special: Where above types are not suitable, furnish boxes to suit the use taking into account space available, appearance, and Code requirements.
3. Switch Boxes:
- a. One-gang/Two-gang Switch Boxes in Standard Walls or Partitions: If able to mount to stud, then 4 inch x 4 inch x 2 1/8 inches; if not, shall be 3 inches x 2 inches square corner boxes by 2 1/2 inches deep with appropriate mounting bracket for attachment to studs.
 - b. One-gang/Two-gang Switch Boxes in Thin Walls or Partitions: If able to mount to stud, then 4 inches x 4 inches x 1 1/2 inch, if not shall be 3 inches x 2 inches square corner boxes by 1 1/2 inches 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 inches wide solid gang boxes, with appropriate "gang" plaster covers as required.
 - d. Gangable boxes are prohibited.
4. 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.
- D. 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 cover plate with spring-hinged waterproof caps suitably configured for each application, including face plate gasket and corrosion resistant fasteners.
- E. 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 NO 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. Formed in field with a cutting tool to provide a clean symmetrically-cut hole.
 - c. Exterior or Wet Areas: Weatherproof galvanized or stainless steel construction with proper gaskets and corrosion resistant fasteners. A parking garage is considered a wet area.
- F. 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 or stainless 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 inches 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, and cabinet doors shall be hinged type.
 5. Each voice/data cabinet shall be equipped with 3/4 inch plywood backboard covering entire inside rear surface and painted matte white with fire resistant paint.
 6. Trims and doors shall have a suitable primer coat and a finish coat of the manufacturer's standard color.
- G. Floor Boxes: Provide fully adjustable floor boxes for installation in concrete floors as indicated. Boxes shall be adjustable both before and after the concrete pour. Unless otherwise noted on the Drawings, provide the following:
1. Waterproof Membrane Floors - Flush Boxes: Concrete tight cast iron floor box with brass trim and service fittings to suit device shown and floor finish.
 2. Non-waterproof Membrane Floors (Above Grade) - Flush Boxes: Concrete tight steel floor box with brass trim and service fittings to suit device shown and floor finish.
- H. Fire-rated Poke-Thru Boxes: Fire-rated, UL listed poke thru boxes for installation through concrete slabs. Boxes shall be suitable for the slab thickness of the building and shall have UL listed abandon plates for use where boxes are removed. Provide poke-thru boxes to suit devices shown and as scheduled on the Drawings.
- I. Conduit Bodies: Provide galvanized cast Malleable Iron Form 7, clip on gasket covers 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.
- J. Bushings, Knockout Closures, and Locknuts: Provide corrosion resistant no stamp knockouts, 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.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Manufacturers Subject to compliance with requirements, provide products by the following manufacturers:
1. Pre-Cast Concrete Handholes and Boxes
 - a. Carder Concrete Products.
 - b. Christy Concrete Products.
 - c. Elmhurst-Chicago Stone Co.
 - d. Oldcastle Precast Group.
 - e. Riverton Concrete Products; a division of Cretex Companies, Inc.
 - f. Utility Concrete Products, LLC.

- g. Utility Vault Co.
 - h. Wausau Tile, Inc.
 - 2. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. CDR Systems Corporation; Hubbell Power Systems.
 - d. NewBasis.
 - e. Oldcastle Precast, Inc.; Christy Concrete Products.
 - f. Synertech Moulded Products; a division of Oldcastle Precast, Inc.
 - 3. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of cast iron.
 - a. Manufacturers: Subject to compliance with requirements, provide products by the following manufacturers:
 - 1) Armorcast Products Company.
 - 2) Carson Industries LLC.
 - 3) CDR Systems Corporation; Hubbell Power Systems.
 - 4) NewBasis.
 - 5) Nordic Fiberglass, Inc.
 - 6) Oldcastle Precast, Inc.; Christy Concrete Products.
 - 7) Synertech Moulded Products; a division of Oldcastle Precast, Inc.
- C. Requirements:
- 1. Concrete Handholes and Boxes
 - a. Comply with ASTM C 858 for design and manufacturing processes.
 - b. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
 - c. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 - d. Cover Finish: Non-skid finish shall have a minimum coefficient of friction of 0.50.
 - e. Cover Legend: Molded lettering, "ELECTRIC".
 - f. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
 - g. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - h. Extension shall provide increased depth of 12 inches (300 mm) or as required for specific site conditions.
 - i. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
 - j. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
 - k. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - l. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - m. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

- n. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - o. Type and size shall match fittings to duct or conduit to be terminated.
 - p. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
 - q. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
2. Handholes and Boxes other than Pre-cast concrete
- a. Standard: Comply with SCTE 77.
 - b. Color: Gray
 - c. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
 - d. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 - e. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - f. Cover Legend: Molded lettering, "ELECTRIC."
 - g. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
 - h. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 - i. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.
- D. Source Quality Control for Underground Enclosures
- 1. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - a. Tests of materials shall be performed by an independent testing agency.
 - b. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - c. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.
- 2.8 PRE-CAST MANHOLES AND UTILITY STRUCTURE ACCESSORIES
- A. PRECAST-MANHOLES
- 1. Manufactures: Subject to compliance with requirements, provide products by one of the following:
 - a. Carder Concrete Products
 - b. Christy Concrete Products
 - c. Elmhurst Chicago Stone Co
 - d. Oldcaste Precast Group
 - e. Riverton Concrete Products; a division of Cretex Companies, Inc.
 - f. Utility Concrete Products, LLC
 - g. Utility Concrete Products, LLC
 - h. Wausau Tile, Inc

2. Comply with ASTM C 858, with structural design loading as specified in Part 3 "Underground Enclosure Application" Article and with interlocking mating sections, complete with accessories, hardware, and features.
 - a. Windows: Pre-cast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300mm) vertically and horizontally to accommodate alignment variations.
 - 1) Windows shall be located no less than 6 inches (150mm) from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
 - 2) Window opening shall have cast in place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - 3) Window opening shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
 - b. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - 1) Type and size shall match fittings to duct or conduit to be terminated.
 - 2) Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.
3. Concrete Knockout Panels: 1-1/2 to 2 inches (38 to 50mm) thick, for future conduit entrance and sleeve for ground rod.
4. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.9 UTILITY STRUCTURE ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one fo the following:
 1. Bilco Company (The)
 2. Campbell Foundry Company.
 3. Carder Concrete Products.
 4. Christy Concrete Products.
 5. East Jordan Iron Works, Inc.
 6. Elmhurst-Chicago Stone Co.
 7. McKinley Iron Works, Inc.
 8. Neenah Foundry Company.
 9. NewBasis.
 10. Oldcastle Precast Group.
 11. Osburn Associates, Inc.
 12. Pennsylvania Insert Corporation.
 13. Riverton Concrete Products; a division of Cretex Companies, Inc..
 14. Strongwell Corporation; Lenoir City Division.
 15. Underground Devices, Inc.
 16. Utility Concrete Products, LLC.
 17. Utility Vault Co.
 18. Wausau Tile, Inc.
 19. Manhole Frames, Covers and Chimney Compone: Comply with structural design loading specified for manhole.
 - a. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces, diameter, 29 inches (737mm).
 - 1) Cover Finish: Non-skid finish sall have a minimum coefficient of friction of 0.50.

- 2) Special Covers: Recess in face of cover designed to accept fresh material in paved areas.
- b. Cover Legend: Cast in, Selected to suit system.
 - 1) Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600V and less.
 - 2) Legend: "ELECTRIC_HV" for duct systems with medium-voltage cables.
 - 3) Legend: "SIGNAL" for communications, data, and telephone duct systems.
- c. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
 - 1) Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu ft (60L) where packaged mix complying with ASTM C387, Type M, may be used.
20. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.
21. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-(50-mm-) diameter eye, and 1 by 4 inch (25 by 100mm) bolt
 - a. Working Load Embedded in 6-Inch (150mm), 4000-psi (27.6 MPa) Concrete: 13,000 lbf (58-kN) minimum tension..
22. Pulling Eyes in Non-concrete Walls: Eyebolt with reinforced fastening; 1-1/4-inch-(32-mm) diameter eye, rated 2500-lbf (11-kN) minimum tension.
23. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
 - a. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension
24. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material, ½ inch (13mm) ID by 2-3/4 inches (69mm) deep, flared to 1-1/4 inches (32mm) minimum at the base.
 - a. Tested Ultimate Pullout Strength: 12,000 lbf (53kN) minimum.
25. Expansion Anchors for Installation after Concrete is Cast: Zinc-plated, carbon-steel wedge type with stainless steel expander clip with 1/2-inch (13mm) bolt, 5300-lbf (24-kN) rated pullout strength, and minimum 6800-lbf (30kN) rated shear strength.
26. Cable Rack Assembly: Nonmetallic Components fabricated from nonconductive fiberglass-reinforced polymer.
 - a. Stanchions: Nominal 36 inches (900mm) high by 4 inches (100mm) wide, with minimum of 9 holes for arm attachment.
 - b. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches (75mm) with 450-lb (204-kg) minimum capacity to 20 inches (508mm) with 250-lb (114kg) minimum capacity. Top of arm shall be normally 4 inches (100 mm) wide and arm shall have slots along full length for cable ties.
27. Duct Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperatures of 300 def F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete mason, lead, cable sheaths, cable jackets, insulation materials and common metals.
28. Fixed Manhole Ladders: Ladder shall be fabricated from nonconductive structural grade, fiberglass-reinforced resin.
29. Cover Hooks: Light duty, designed for lifts less than 60 lbf (270 N)

2.10 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.

- B. Non-Concrete Handhold and Pull Box Prototype Test. Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied. Control.
- C. Test of materials shall be performed by an independent testing agency.
- D. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify test by manufacturer.
- E. Testing machine pressure gauges shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: GRC (GRS) or IMC or RNG, Type EPC-80-PVC. RNC conduit is not allowed on or above roofs.
 - 2. Concealed Conduit, Aboveground: EMT.
 - 3. Underground Conduit (Service entrance and feeders): Concrete encase RNG, Type EPC-40-PVC or Type EPC-80-PVC.
 - 4. Underground Conduit (Branch Circuits): Type EPC-80-PVC, direct buried.
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic Electric Solenoid, or Motor Driven Equipment) LFMC
 - 6. Boxes and Enclosures, Aboveground: NEMA 250 Type 3R
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT
 - 2. Exposed, Not Subject to Severe Physical Damage (EMT)
 - 3. Exposed and Subject to Severe Physical Damage (below 20 ft in elevation). GRC, (GRS) or IMC. Raceway locations include, but are not limited to, the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Central Plants.
 - d. Gymnasiums.
 - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic Electric Solenoid, or Motor-Driven Equipment). FMC, except use LFMC in damp or wet locations.
 - 6. Damp or Wet locations: GRC (GRS) or IMS.
 - 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise directed. Comply with NEMA FB 2.10.
 - 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer, and apply in thickness and number of coats recommended by manufacturer.

3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install surface raceways only where indicated on Drawings.
- F. Do not install non-metallic conduit at roof applications or where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

A. General:

1. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
2. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot water pipes. Install horizontal raceways runs above water and steam piping.
3. Complete raceway installation before starting conductor installation.
4. Comply with requirements in Section 260529 – “Hangers and Supports for Electrical Systems: for hangers and supports.
5. Comply with requirements if 260553, “Identification for Electrical Systems” for applicable labeling, painting and nameplates.
6. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

B. Installation of raceways above ground:

1. Conceal conduit and EMT within finished walls, ceilings and floors unless otherwise indicated.
2. Install above grade conduits parallel or perpendicular to building lines.
3. Support conduit within 12 inches (300 mm) of enclosures to which attached.
4. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
5. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions. Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer’s written instructions.
6. Coat field-cut threads on PVC-coated raceways with a corrosion-preventing conductive compound prior to assembly.
7. Raceway Terminations at Locations Subject to Moisture or Vibration. Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
8. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
9. Install raceways square to the enclosure and terminate at enclosures with **locknuts**. Install locknuts hand tight plus 1/4 turn more.
10. Do not rely on locknuts or penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
11. Cut conduit perpendicular to the length. For conduits 2-inch (53 mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

12. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- C. Installation of raceways below ground
1. General
 - a. Arrange stub-ups so curved portions of bends are not visible above finished slab.
 - b. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - c. Couple steel conduits to raceways of different material using adapters listed for the application, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
 - d. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
 2. Direct Buried
 - a. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom with a minimum of 3" sand bed for raceways.
 - b. Direct buried conduits, not installed in duct bank, shall be installed a minimum of 18 inches below finished grade. Comply with NEC unless noted otherwise on the Drawings.
 - 1) Provide PVC spacers at 5 feet on center to maintain 2" of separation between raceways in multiple raceway applications.
 - 2) Maintain 12 inches of earth or 2 inches of concrete separation between electrical conduits and other services or utilities below grade. Maintain 10 feet separation between parallel underground power and voice/data conduits. Where power and voice/data conduits cross below grade, crossing shall be at right (90 degree) angles with a minimum 2 feet vertical separation.
 - c. Install breathers and drains unless the electrical equipment is installed indoors. Breathers and drains shall also be installed in enclosures to ensure draining of all liquids that condense or otherwise enter the enclosure. Conduit systems shall be installed in such a manner as to minimize the accumulation of moisture at low points and pockets. Where low points and pockets are unavoidable, a conduit fitting at the low point with a drain plug shall be installed. Vertical conduits located outdoors that enter equipment or device enclosures shall be low point drain fittings; conduit entry to enclosures shall be through the side or bottom. Conduit top entries shall be avoided and if required shall be reviewed and approved by Authority Having Jurisdiction. Conduits entering buildings shall have low point drain fittings installed to prevent liquids that have collected in the conduits from entering the building conduit system.
 - d. After installing conduit, backfill and compact. Provide backfill material as follows:
 - 1) Provide 9" of sand backfill above raceways.
 - 2) Provide compacted select backfill above the sand.

Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with mechanical compaction to 90%, +/- 5%, in maximum 5" lifts.

- e. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
 - f. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.]
 - g. Underground Warning Tape: Comply with requirements in Section 260533 "Identification for Electrical Systems."]
3. Ductbanks
- a. Power duct banks shall be of individual conduits, encased in steel reinforced concrete. Conduit material shall be rigid PVC Schedule 40, except that rigid steel conduit or RTRC shall be used for the final 10 feet at the beginning and end of each duct bank and for all elbows and stub-ups. The reinforced concrete encasement surrounding the duct bank shall be rectangular in cross section, having a minimum concrete thickness of 3 inches. Conduits shall be separated by a minimum 2 inch concrete thickness, except that light and power conduit shall be separated from control and signal conduits by a minimum concrete thickness of 3 inches. Encasement concrete shall be red in color.
 - b. Concrete may be omitted for any portion of the run that is directly below a building slab on grade.
 - c. Changes in direction of duct bank 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 feet. All bends in a run shall be separated by a minimum of 10 feet of straight conduit, where possible.
 - d. During construction, partially completed duct banks 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 duct bank 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 and temporarily sealed.
 - e. Ducts in concrete encased duct banks shall be independently supported by interlocking module spacers manufactured by Formex or approved substitution. Spacers shall provide separation between adjacent ducts as specified hereinabove. Spacers shall be installed at maximum 6 feet intervals.
 - f. Ducts in concrete encased duct banks shall be terminated in manholes, pull boxes, and vaults with interlocking terminators manufactured by Formex or approved substitution. 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.
4. Raceways in slab
- a. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
 - b. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - c. Arrange raceways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions. Do not install conduits within concrete slabs less than 6 inches (150 mm) thick.
 - d. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

D. Installation of empty raceway systems:

1. Provide pull wires for empty raceway systems. 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 inches of slack shall be left at each end of the pull wire.
- E. Installation of wireways and cabinets
1. General: Install wireways and cabinets where shown and comply with specifications, in accordance with the manufacturer's written instructions, NEC, NECA's "Standard of Installation", and with recognized industry practices to ensure that the installation complies with the specified requirements and serve the intended purposes. Comply with requirements of NEMA and the NEC pertaining to installation of wireways.
 2. Finishing: Remove burrs and sharp edges of wireways and cabinets to avoid damage to wiring insulation or jacket.
 3. Grounding: Electrically ground wireways and cabinets to ensure continuous electrical conductivity. Refer to Section 26 0526 "Grounding and Bonding for Electrical Systems."
 4. Cables:
 - a. Complete wireway and cabinet installation before starting the installation of cables.
 - b. Provide sufficient space to permit access for installing, splicing, and maintaining the cables.
 - c. Provide slack cable, where noted on the Drawings, to provide flexibility for future taps and modifications.
 - d. Provide retaining clips on minimum 5 feet on center where the raceway orientation will allow cables to shift or fall out when the cover is opened and removed.
- F. Installation of Boxes
1. Provide junction and pull boxes for feeders and branch circuits where shown. Provide additional pull boxes where required by the NEC.
 2. Install in compliance with NEC requirements, these specifications, 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.
 3. Where boxes are concealed in exterior walls, the continuity of the vapor barrier shall be maintained behind the box.
 4. Use outlet and switch boxes for junctions on concealed conduit systems except in utility areas where exposed junction or pull boxes may be located.
 5. 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 Engineer 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.
 6. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
 7. On exposed conduit systems, provide pull boxes, junction boxes, wiring troughs, and cabinets wherever necessary for proper installation of various electrical systems.
 8. Do not install pullboxes or wireways for the following purposes:
 - a. to aggregate homeruns to panelboards
 - b. to contain wiring from circuits originating in different panelboards.

- c. to contain wiring from systems with different voltages.
9. Provide weatherproof boxes for interior and exterior locations exposed to weather or moisture.
 10. Provide knockout closures to cap unused knockout holes where blanks have been removed. Maintain 48 inches minimum clearance in front of branch box circuitry.
 11. Locate boxes and conduit bodies to ensure accessibility of electrical wiring. Never set junction boxes above lights on lay-in ceilings.
 12. 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.
 13. Boxes for any conduit system shall not be secured to the ceiling system, HVAC ductwork, or mechanical piping.
 14. 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 Engineer in writing where modifications or additional construction are required to maintain the partition or slab fire rating.
 15. All junction boxes in accessible locations shall be marked with a permanent marker to identify the circuit(s) including voltage level within the box and on box cover.
 16. Junction boxes utilized for emergency circuits shall be painted red in color.
 17. Do not locate wall outlet boxes back-to-back in the same stud wall cavity. Ensure that communications and electrical outlet boxes are placed at least one stud or 16 inches apart when located on opposite sides of a partition wall.
 18. 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:

NUMBER IN GANG	SIZE
3	4-1/2 inches by 8-5/8 inches
4	4-1/2 inches by 10-1/2 inches
5	4-1/2 inches by 10-1/2 inches
6	4-1/2 inches by 14 inches

19. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
20. Switch boxes shall not be used as junction boxes. They should only contain the wiring pertaining to the circuit.
21. Install boxes in walls without damaging wall insulation.
22. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
23. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.
24. 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. Also, stabilize box hanger with use of caddy T-bar.
25. Set floor boxes level and flush with floor. Install nonrated floor boxes as detailed on the Drawings.
26. Locate pull boxes and junction boxes in easily accessible area, above accessible ceilings or in unfinished areas.

27. 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 or caddy adjustable box bracket.
 28. Outlet boxes in plaster partitions shall be "shallow-type" set flush in wall so there is at least 5/8 inch plaster covering back of box. Box size shall be 4 inches x 4 inches x 2 1/8 inches or 1 1/2 inches depending on application.
 29. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
 30. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
 31. Locate boxes so that cover or plate will not span different building finishes.
 32. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
 33. Set metal floor boxes level and flush with finished floor surface.
 34. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- G. Installation of Handholes
1. Install handholes in accordance with the details, where shown on the Contract Documents and manufacturer's written installation instructions. Handholes shall be rigidly supported and level with the top of manhole rings flush with finished paving or grade at the point of installation.
- H. Installation of Manholes
1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
 2. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
 3. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.
 4. Install handholes with bottom below frost line.
 5. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.
 6. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- I. Surface Raceways:
1. General: Install surface raceways where shown and comply with specifications, in accordance with the manufacturer's written instructions, NEC, NECA's "Standard of Installation", and with recognized industry practices to ensure that surface raceways comply with the specified requirements and serve the intended purposes.
 2. Mounting: Mount surface raceways in accordance with the manufacturer's listed installation instructions and the requirements of the local Electrical Inspection Department.
 3. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
 4. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support

surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

5. Protection of surface raceway receptacles
 - a. General: Upon installation of multi-outlet surface raceways, advise Contractor regarding proper and cautious use of convenience outlets. At the time of Substantial Completion, replace those items which have been damaged, including those burned and scored by faulty plugs.
 6. Testing
 - a. General: Prior to energization, check for continuity of circuits, for short circuits and check grounding connections. Verify that each individual raceway outlet is energized and that hot, neutral and ground conductors are properly connected.
- J. Specialty Fittings:
1. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
 2. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - b. Where an underground service raceway enters a building or structure.
 - c. Where otherwise required by NFPA 70.
 3. Cable Support Fittings: Install in long vertical raceways according to spacing requirements in NEC Table 300.19(A) "Spacings for Conductor Supports". Locate fittings in an accessible location and provide access doors where raceway is concealed behind wall or ceiling finishes.
- K. Expansion-Joint Fittings:
1. Locations Required:
 - a. Install in vertical section of conduit stub-ups routed through underfloor spaces, below the sleeved floor opening.
 - b. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m).
 - c. Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
 - d. Attics: 135 deg F (75 deg C) temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction

for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for steel conduits.

4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

L. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.4 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

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 DESCRIPTION OF WORK

- A. Section Includes:
 - 1. Sleeves for raceway and cable penetration of non fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.

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, cutsheets of proposed products.
- B. Closeout Submittal
 - 1. Include final version of approved shop drawing submittals within the Operation and Maintenance manual.
- C. LEED Submittals:
 - 1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
 - 2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:
 - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, Subject to compliance with requirements, provide products by the following:
 - a. Advance Products & Systems, Inc.
 - b. CALPICO, Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
 - f. Eaton – Crouse Hinds
 - g. GPT Industries
 - 2. Sealing Elements: EPDM or Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Plastic or Stainless steel.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
 - 1. Manufacturers: Subject to compliance with requirements, Subject to compliance with requirements, provide products by the following:
 - a. Presealed Systems.

2.4 GROUT

- A. Description: Non-shrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

- C. Design Mix: 5,000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Pre-mixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multi-component, silicone-based, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Seal the space around outside of sleeve-seal fittings with grout.

END OF SECTION

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 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 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and IEEE C2.
- B. Comply with NFPA 70 and 70E.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Comply with NFPA 70 and NFPA 70E requirements for ARC-flash warning labels

1.4 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 the Contract Documents.

1.5 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.

- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.6 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
- C. Snap-Around Labels: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.2 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

2.3 FLOOR MARKING TAPE

- A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.4 DETECTABLE UNDERGROUND-LINE WARNING TAPE

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Brady
 - b. Scotch
 - c. Presco
 - d. Trumbull MFG.
- B. Tape:
 - 1. Minimum 5.0 mil overall thickness with .35 mil, solid aluminum foil core.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- C. Color and Printing:
 - 1. Comply with ANSI Z535.1 through ANSI Z535.5.
 - 2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE, .
 - 3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.
- D. Tape Width:
 - 1. Minimum tape width shall correspond to burial depth below final, finished grade as follows:
 - a. 2" wide for 6"-12" installed depth, below finished grade.
 - b. 3" wide for 12"-24" installed depth, below finished grade.
 - c. 6" wide for 22"-30" installed depth, below finished grade.

2.5 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."
 - 3. ARC FLASH

2.6 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
- B. Stenciled Legend: In non-fading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.8 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
 1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 4. Color: Black except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
 1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
 1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
 3. UL 94 Flame Rating: 94V-0.
 4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
 5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.
- I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line. Depth below final finished grade shall not exceed amount indicated per these specifications or as published in the tape manufacturer's installation instructions. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.
- J. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. Provide identification products after completion of all finish painting. System legends shall be as follows:
 - 1. Emergency Power.
 - 2. Power.
 - 3. UPS.

- B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Purple.
 - 2) Phase B: Brown.
 - 3) Phase C: Yellow.
 - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- C. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use write-on tags and a separate tag with the circuit designation].
- D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- E. Conductors to be extended in the future: Attach write-on tags to conductors and list source.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
 - 1. Install underground-line detectable warning tape for both direct-buried cables and cables in raceway.
- H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
 - 1. Comply with 29 CFR 1910.145.

2. Identify system voltage with black letters on an orange background.
 3. Apply to exterior of door, cover, or other access.
 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
- J. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- K. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer or load shedding
- L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Fasten labels with appropriate stainless steel mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 2. Equipment to be Labeled:
 - a. Panelboard identification shall be engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchgear.
 - e. Switchboards.
 - f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - g. Substations.
 - h. Emergency system boxes and enclosures.
 - i. Motor-control centers.
 - j. Enclosed switches.
 - k. Enclosed circuit breakers.
 - l. Enclosed controllers.
 - m. Variable-speed controllers.
 - n. Push-button stations.
 - o. Power transfer equipment.
 - p. Contactors.
 - q. Remote-controlled switches, dimmer modules, and control devices.
 - r. Battery-inverter units.

- s. Battery racks.
 - t. Power-generating units.
 - u. Monitoring and control equipment.
 - v. UPS equipment.
3. Equipment Requiring Directory and/or branch device labels:
- a. Panelboards: Typewritten directory of circuits corresponding to "as-installed" device and load locations.
 - b. Switchgear.
 - c. Switchboards.
 - d. Lighting Control panels
 - e. Dimmer circuits.
 - f. Monitoring and control equipment.

END OF SECTION

SECTION 260573 - POWER SYSTEMS STUDIES

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 DESCRIPTION OF WORK

A. General

1. Scope - The contractor shall provide an engineering analysis and power system studies for the [entire electrical system including existing equipment] [new portions of electrical distribution system] as required hereinbelow.
2. The Short Circuit Analysis, Protective Device Coordination Study, [Emergency Power System Selective Coordination Study] and Arc Flash and Electrical Hazard Studies specified in this section shall be completed and submitted prior to submitting submittals for [switchgear], switchboards, [motor control centers], distribution panels, panelboards, enclosed circuit breakers and other electrical gear with short circuit or interrupting ratings.
3. The power system studies shall be performed in SKM with the final native files provided to the Owner. The contractor shall perform a Power System Short Circuit Analysis, Protective Device Coordination Study, [Emergency Power System Selective Coordination Study] and Arc Flash and Electrical Hazard Study. These analyses and studies shall include all power distribution systems, beginning at the electric service point from the Electric Utility Company or campus utility power source [and emergency power source(s)] to the secondary buses of each panelboard as described hereafter. In addition, include harmonic systems and ground grid studies.
4. The electrical 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.
5. The Load Flow Analysis shall start at the electrical power source and terminate at each branch bus at the lowest utilization voltage. The load flow analysis shall also include a voltage drop study beginning at the electrical power source and terminate at each branch bus at the lowest utilization voltage.]
6. 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 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.
7. 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.

8. The Emergency Power System Selective Coordination Study shall comply with all applicable NEC requirements and shall start at the electric service and emergency power source(s) and include all electrical distribution equipment protective devices to and including the final branch circuit protective devices serving applicable emergency loads. 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 final branch circuit protective devices serving applicable emergency loads. The protective device study shall include a separate analysis for phase and ground protection.
 9. 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 electrical equipment such as, but not limited to, switchgear, switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project. If the Arc flash energy exceeds 40 cal/cm², an Arc flash energy reduction option shall be reviewed and provided by the Engineer to the Owner for review and approval. The intention is to lower the energy to the extent possible, preferably less than 10 cal/cm².
 10. 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 to longest possible lengths. All other equipment ratings shall be obtained by the Contractor from the equipment manufacturers 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 and phase to ground 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.
 4. Symmetrical RMS short circuit amperes calculated using total source and motor contribution reactance and resistance values.
 5. Asymmetrical average 3 phase RMS amperes at 1/2 cycle, calculated using actual total source and motor contribution X/R ratio.
 6. 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.
 7. 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.
 8. 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.
 9. 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.

10. 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.
 11. 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.
 12. 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.
 13. 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 plot 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 motors greater than 50 HP that are starting on line (DOL), starting characteristics and 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 and 0.3 for electronic relays, 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 [service continuity] [system protection] considered more important than [system protection/service continuity.] The time-current coordination analysis shall be performed with the aid of appropriate software. In addition, Arc flash energy reduction consideration shall be included.
 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.
Delete if there is no emergency Power System on the project.
- D. Emergency Power System Selective Coordination Study: The Study shall include the following:
1. Confirmation of selective coordination of all overcurrent devices associated with supplying utility and generator/UPS to emergency loads in accordance with all applicable requirements of NEC Article 100 and Paragraphs 700.27 and 701.18. Study shall be based on coordination to [0.1] [0.01] seconds. Study shall be based on the actual electrical equipment and overcurrent protective devices being submitted for the project.
 2. 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.
 3. Circuit breakers shall indicate manufacturer and type and 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. Circuit breaker curves shall include complete operating bands, terminating with the appropriate available short circuit current.
 4. Fuses shall have a fuse manufacturer and type indicated. Fuse curves shall be identified as either total clearing time or damage time as applicable.
 5. Microprocessor relays shall indicate manufacturer and type and 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 0.30 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.
 6. 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.
 7. Confirmation that the proposed overcurrent protection devices, set or selected as recommended, will provide the specified selective coordination. Should the overcurrent devices proposed for the project not be capable of providing the specified selective coordination, the report shall include recommendations for overcurrent protective device changes required to provide the specified coordination and calculations, plots, recommended settings as specified herein for the recommended overcurrent device changes to provide the specified selective coordination.
 8. All information shall be presented in a report form, signed and sealed by the Engineer providing the analysis.
- E. 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, NFPA 70E, 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 buses based on available short-circuit current, protective device clearing time and other applicable one-line diagram information. Incident energy calculations shall be provided at line and load side. Including all DC systems.

- b. Calculate the Arc Flash Boundary and incident energy for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
- c. Establish the Arc Flash Protection Boundary (Shock Protection Boundaries: Limited and restricted approach boundary) as required by NFPA 70E for each piece of electrical equipment such as, but not limited to, switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker and disconnect switch to be installed on the project.
- d. Provide equipment specific Arc-flash hazard warning label requirements per NEC Section 110.16 for each switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker, disconnect switch and all DC systems to be installed on the project, including all information specified to be provided on individual equipment warning labels. Arc Flash Labels shall meet all of the following requirements per NFPA 70 and 70E. Per NFPA 70E, equipment labeling, shall contain available incident energy and the corresponding working distance only. Arc Flash Energy greater than 40 cal/cm² shall be color coded red with additional notes that equipment shall not be operated. Arc Flash Labels shall be submitted to the Owner for review and approval of information to be included on labels.
- e. Provide recommendations and methods to mitigate the hazard risk, where applicable, in order to reduce PPE requirements. If the Arc flash energy exceeds 40 cal/cm², an Arc flash energy reduction option shall be provided to the Owner for review and approval. The intention is to lower the arc flash energy, if possible, to less than 10 cal/Cm².
- f. Harmonic systems analysis: For power systems that include electronic switching devices such as adjustable speed drives (ASDs), soft starters, or uninterruptible power supply (UPS) systems, a harmonic study shall be performed. The study shall determine if the total harmonic distortion on any bus that supplies loads, other than electronically switched devices, is more than 5 percent and does not comply with IEEE 519. The harmonic study shall also determine if any negative actions, such as the tripping of circuits or overvoltage conditions, can result due to switching of power factor correction capacitor systems. If so, corrective measures may be required (consult with the Owner).
- g. Ground Grid Studies: A study shall be done during the design phase to help determine the required number and type of ground rods required to meet the desired resistance levels as identified Normally, the grounding electrode system shall have a resistance to earth of 5 ohms or less as verified by testing. Some instrument systems, especially those using intrinsically safe systems, require a resistance to earth of 1 ohm or less. A study shall be done during the design phase to verify that the required number and type of ground rods are installed to meet these resistance levels. The study shall be based on measured soil conditions or as directed by the Owner. A grounding study based on IEEE 80 and IEEE 142 shall be performed whenever a utility-fed main outdoor substation yard is in the scope of work. Calculations showing the touch and step potential in the outdoor substation shall be submitted to the Owner.
- 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 distribution equipment for interrupting rating, coordination and arc flash related coordination.

1.4 QUALITY ASSURANCE

- A. All electrical studies shall be performed by the Engineering Department of the electrical equipment supplier for the project or by a qualified engineering consultant.

1.5 SUBMITTALS

- A. Shop drawing submittals shall include, but not be limited to, the following:
1. Four copies of the Load Flow 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 listing of the equipment regarding the normal current carrying capacity and normal current load. In addition, the voltage drop results shall be provided for every cable.
 2. 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.
 3. 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.
 4. Four copies of the Emergency Power System Selective Coordination Study including, but not limited to:
 - a. Time-current characteristic curve drawings on log-log printouts which illustrate:
 - 1) Compliance of the provided overcurrent protective devices with the specified selective coordination requirements.
 - 2) The recommended settings for all adjustable relays, overcurrent protective devices and ground fault protective devices provided for the project.

- 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 the specified selective coordination shall be called to the attention of the Engineer with recommendations for improved coordination.
5. Four copies of all the electrical powers studies including, but not limited to:
 - a. Minimum Arc Fault Current, Shock and 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 because 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 Arc Flash Protection Boundary (approach limit distance) as required by NFPA 70 and NFPA 70E 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 and NFPA 70E 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, to reduce PPE requirements.
6. Cut sheets and submittal information on the Arc Flash warning labels being provided.
7. Additional information as required in Section 26 0001 "Basic Requirements for Electrical".
8. Contractor to provide all electronic data files (SKM, ETAP, etc.) to Owner at the conclusion of the project as part of close out documentation.

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. If the Arc flash energy exceeds 40 cal/cm², an Arc flash energy reduction option shall be provided to the Owner for review and approval. The intention is to lower the energy, if possible, to less than 10 cal/cm².

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 ARC FLASH WARNING LABELS
- A. Installation: Arc Flash warning labels shall be securely affixed to each of electrical equipment such as, but not limited to, switchboard, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker, disconnect switch and all DC battery systems in a readily visible location in accordance with NEC and OSHA requirements.

END OF SECTION

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Time switches.
2. Photoelectric switches.
3. Standalone daylight-harvesting switching controls.
4. Indoor occupancy sensors.
5. Outdoor motion sensors.
6. Lighting contactors.
7. Emergency shunt relays.

B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 DEFINITIONS

- A. LED: Light-emitting diode
- B. PIR: Passive infrared

1.4 SUBMITTALS

A. Shop Drawing submittals shall include, but not be limited to, the following:

1. Product Data: For each type of lighting control device proposed for use on the project.
2. Shop Drawings: Showing installation details for occupancy and light-level sensors. Provide interconnection diagrams showing field installed wiring. Include diagrams for power, signal, and control wiring.

B. Closeout Submittal

1. Include final version of approved shop drawing submittals within the Operation and Maintenance manual.

1.5 QUALITY ASSURANCE

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

1.6 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. NSi Industries LLC; TORK Products.
 - 2. Cooper Industries, Inc.
 - 3. Intermatic, Inc.
 - 4. Lutron Electronics Co., Inc
 - 5. Square D; Schneider Electric.
 - 6. Leviton Mfg. Company Inc.
 - 7. Watt Stopper (The).
 - 8. Tyco Electronics; ALR Brand.
 - 9. Lithonia Lighting; Acuity Lighting Group, Inc.
- B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
 - 1. Contact Configuration: [SPST] [DPST] [DPDT] <Insert configuration>.
 - 2. Contact Rating: [30-A inductive or resistive, 240-V ac] [20-A ballast load, 120-/240-V ac] <Insert rating>.
 - 3. Programs: Eight on-off set points on a 24-hour schedule[and an annual holiday schedule that overrides the weekly operation on holidays].
 - 4. Programs: Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week[and an annual holiday schedule that overrides the weekly operation on holidays].
 - 5. Programs: <Insert number> channels; each channel is individually programmable with eight on-off set points on a 24-hour schedule.
 - 6. Programs: <Insert number> channels; each channel is individually programmable with two on-off set points on a 24-hour schedule with a skip-a-day weekly schedule.
 - 7. Programs: <Insert number> channels; each channel is individually programmable with two on-off set points on a 24-hour schedule, allowing different set points for each day of the week.
 - 8. Programs: <Insert number> channels; each channel is individually programmable with 40 on-off operations per week and an annual holiday schedule that overrides the weekly operation on holidays.

9. Programs: <Insert number> channels; each channel is individually programmable with 40 on-off operations per week, plus four seasonal schedules that modify the basic program, and an annual holiday schedule that overrides the weekly operation on holidays.
 10. Programs: <Insert configuration>[and an annual holiday schedule that overrides the weekly operation on holidays].
 11. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
 12. Astronomic Time: All channels.
 13. Automatic daylight savings time changeover.
 14. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.
- C. Electromechanical-Dial Time Switches: Comply with UL 917.
1. Contact Configuration: [SPST] [DPST] [SPDT] [DPDT] <Insert configuration>.
 2. Contact Rating: [30-A inductive or resistive, 240-V ac] [20-A ballast load, 120-/240-V ac] <Insert rating>.
 3. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.
 4. Astronomic time dial.
 5. Eight-Day Program: Uniquely programmable for each weekday and holidays.
 6. Skip-a-day mode.
 7. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Cooper Industries, Inc.
 2. Intermatic, Inc.
 3. NSi Industries LLC; TORK Products.
 4. Watt Stopper (The).
- B. Description: Solid state, with DPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
1. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
 2. Time Delay: Fifteen second minimum, to prevent false operation.
 3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
 4. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.3 DAYLIGHT-HARVESTING SWITCHING CONTROLS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Cooper Industries, Inc.

2. Eaton Corporation.
 3. Hubbell Building Automation, Inc.
 4. Leviton Mfg. Company Inc.
 5. Lithonia Lighting; Acuity Lighting Group, Inc.
 6. NSi Industries LLC; TORK Products.
 7. Sensor Switch, Inc.
 8. nLight Controls.
 9. Watt Stopper.
 10. Lutron Electronics Co., Inc
- B. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with separate power pack/relay, to detect changes in indoor lighting levels that are perceived by the eye.
- C. Electrical Components, Devices, and Accessories:
1. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
 2. Sensor Output: Contacts rated to operate the associated power pack, complying with UL 773A. Sensor is powered by the power pack.
 3. Power Pack: Dry contacts rated for 20A ballast load at 120- and 277-V ac, for 13A tungsten at 120-V ac, and for 1hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 4. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lux), with an adjustment for turn-on and turn-off levels within that range.
 5. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1000 fc (1080 to 10 800 lux), with an adjustment for turn-on and turn-off levels within that range.
 6. Skylight Sensors Light-Level Monitoring Range: 1000 to 10,000 fc (10 800 to 108 000 lux), with an adjustment for turn-on and turn-off levels within that range.
 7. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
 8. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
 9. Test Mode: User selectable, overriding programmed time delay to allow settings check.
 10. Control Load Status: User selectable to confirm that load wiring is correct.
 11. Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.4 DAYLIGHT-HARVESTING DIMMING CONTROLS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Cooper Industries, Inc.
 2. Hubbell Building Automation, Inc.
 3. Leviton Mfg. Company Inc.
 4. Lithonia Lighting; Acuity Lighting Group, Inc.
 5. Watt Stopper.
 6. Lutron Electronics Co., Inc
 7. nLight Controls
- B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
1. Lighting control set point is based on two lighting conditions:

- a. When no daylight is present (target level).
 - b. When significant daylight is present.
2. System programming is done with two hand-held, remote-control tools.
 - a. Initial setup tool.
 - b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.
- C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Sensor Output: 0- to 10-V dc to operate electronic dimming ballasts. Sensor is powered by controller unit.
 3. Power Pack: Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.
 4. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc (120 to 640 lux).

2.5 INDOOR OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Hubbell Building Automation, Inc.
 2. Leviton Mfg. Company Inc.
 3. Lithonia Lighting; Acuity Lighting Group, Inc.
 4. Lutron Electronics Co., Inc.
 5. NSi Industries LLC; TORK Products.
 6. Sensor Switch, Inc.
 7. Square D; a brand of Schneider Electric.
 8. Watt Stopper.
- B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
1. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
 3. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 5. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 6. Bypass Switch: Override the "on" function in case of sensor failure.

7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.
- C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.
1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.
- D. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy .
1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).
- E. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
- 2.6 HIGH-BAY OCCUPANCY SENSORS
- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Hubbell Building Automation, Inc.
 2. Leviton Mfg. Company Inc.
 3. Lithonia Lighting; Acuity Lighting Group, Inc.
 4. Lutron Electronics Co., Inc.
 5. Sensor Switch, Inc.
 6. Square D; a brand of Schneider Electric.
 7. Watt Stopper.

- B. General Description: Solid-state unit. The unit is designed to operate with the lamp and ballasts indicated.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.
 3. Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.
 4. Operating Ambient Conditions: 32 to 149 deg F (0 to 65 deg C).
 5. Mounting: Threaded pipe.
 6. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 7. Detector Technology: PIR.
 8. Power and dimming control from the lighting fixture ballast that has been modified to include the dimming capacitor and MyzerPORT option.
- C. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet (3.7 to 15.2 m).
- D. Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

2.7 OUTDOOR MOTION SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. NSi Industries LLC; TORK Products.
 2. Cooper Industries, Inc.
 3. Hubbell Building Automation, Inc.
 4. Leviton Mfg. Company Inc.
 5. Lithonia Lighting; Acuity Lighting Group, Inc.
 6. Watt Stopper.
- B. Performance Requirements: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F, rated as rain-tight according to UL 773A.
1. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 2. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outdoor junction box.
 - b. Relay: Internally mounted in a standard weatherproof electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 3. Bypass Switch: Override the on function in case of sensor failure.
 4. Automatic Light-Level Sensor: Adjustable from 1 to 20 fc; keep lighting off during daylight hours.
- C. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.
- D. Detection Coverage: Up to 35 feet, with a field of view of 180 degrees.

- E. Lighting Fixture Mounted Sensor: Suitable for switching 300 W of tungsten load at 120- or 277-V ac.
- F. Individually Mounted Sensor: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 - 1. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 - 2. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

2.8 LIGHTING CONTACTORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Allen-Bradley/Rockwell Automation.
 - 2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
 - 3. Eaton Electrical Inc.; Cutler-Hammer Products.
 - 4. GE Industrial Systems; Total Lighting Control.
 - 5. Grasslin Controls Corporation; a GE Industrial Systems Company.
 - 6. Hubbell Lighting.
 - 7. Square D; Schneider Electric.
 - 8. TORK.
 - 9. Watt Stopper (The).
- B. Description: Electrically operated and mechanically held, combination-type lighting contactors with nonfused disconnect, complying with NEMA ICS 2 and UL 508.
 - 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 - 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 - 3. Enclosure: Comply with NEMA 250.
 - 4. Provide with control and pilot devices as scheduled, matching the NEMA type specified for the enclosure.
- C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.
 - 1. Monitoring: On-off status.
 - 2. Control: On-off operation.

2.9 EMERGENCY SHUNT RELAY

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Lighting Control and Design; Acuity Lighting Group, Inc.
 - 2. Watt Stopper.

- B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

- 1. Coil Rating: [120] [277] V.

2.10 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

- A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

- A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to evaluate lighting control devices and perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections[with the assistance of a factory-authorized service representative:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Lighting control devices will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
 - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
 - 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.7 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 260943 "Network Lighting Controls."
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Project Closeout."

END OF SECTION

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 26 Section 260573, "Power Systems Studies".
 - 2. Division 26 Section 260553, "Electrical Identification" for identification materials.
 - 3. Division 26 Section 262813, "Fuses".

1.2 DESCRIPTION OF WORK

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Branch-circuit panelboards.
 - 3. [Circuit breakers for existing building panelboards.]
 - 4. [Electronic-grade panelboards.]

1.3 SUBMITTALS

- A. Shop Drawings -
 - 1. Power Systems Studies specified in Section 260573, shall be completed and submitted prior to submitting shop drawings for this section.
 - 2. For each panelboard and related equipment, provide:
 - a. Dimensioned plans, elevations, sections, and details. Show schedules of installed devices, equipment features, and ratings. Overcurrent device order and phase assignment shall match those scheduled on Contract Documents.
 - b. Enclosure types, material, environmental rating, and construction details.
 - c. Bus, current, and voltage ratings.
 - d. Short-circuit current rating of panelboards and overcurrent protective devices.
 - e. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - f. Wiring diagrams for power, signal, and control wiring, if present.
 - g. Time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.
 - h. Additional information as required in Section 26 0001, "Basic Requirements for Electrical".
- B. Closeout Submittal
 - 1. Include final version of approved shop drawing submittals within the Operation and Maintenance manual.
 - 2. Provide manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. UL Standards: Panelboards and enclosures shall conform to all applicable UL standards and shall be UL-labeled.
- E. Comply with NFPA 70.
- F. Products shall be designed, manufactured, tested, and installed in compliance with the following standards:
 - 1. NEMA PB 1 Panelboards
 - 2. NEMA AB 1 Molded Case Circuit Breakers
 - 3. NEMA KS 1 Enclosed Switches
 - 4. NEMA PB 1.1 Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

1.5 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Enclosures: Refer to drawings and schedules for cabinet mounting requirements.
1. Distribution Panel Enclosures: Distribution panel enclosures shall be code gauge galvanized steel with wire bending space per the NEC. 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. [Covers for panelboards installed in any areas subject to moisture shall be stainless steel.]
 2. Panelboard Enclosures: Panelboard enclosures shall be code gauge galvanized steel with wire bending space per the NEC. Panelboard enclosures shall be minimum 16 gauge thickness, minimum 20" width, without 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 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 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. Trim on flush mounted panels shall have concealed fasteners. [Covers for panelboards installed in any areas subject to moisture shall be stainless steel.] 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 minimum 1" gap.
 3. Provide cabinets rated for environmental conditions at locations indicated on the drawings. If not otherwise noted on the drawings or schedules, refer to the following:
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 4. Front: For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 5. [Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.]
 6. Finishes:
 - a. Panels and Trim: Galvanized steel, factory finished immediately after cleaning and pre-treating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.

- c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
 - 7. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
 - C. Incoming Mains Location: Coordinate a planned route for panelboard feeders prior to submittal. Provide mains at locations required by the panel location and feeder routing.
 - D. Phase, Neutral, and Ground Busses:
 - 1. Material: Tin-plated aluminum or Hard-drawn copper, 98 percent conductivity.
 - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 - 3. Provide Neutral Bus rated 200% of phase bus and UL listed as suitable for nonlinear loads where scheduled on drawings or if supplied by K-rated or phase cancellation transformers
 - E. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Tin-plated aluminum or Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Compression type.
 - 3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
 - 4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - 5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 - 6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 - 7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
 - F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
 - G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
 - H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.
- 2.2 DISTRIBUTION PANELBOARDS
- A. Panelboards: NEMA PB 1, power and feeder distribution type.
- 2.3 BRANCH-CIRCUIT PANELBOARD
- A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

2.4 OVERCURRENT PROTECTIVE DEVICES

- A. Mains: Provide rating as scheduled
- B. Common Requirements
 - 1. 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.
 - 2. 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.
 - 3. 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".
 - 4. 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:
Voltage (volts) Interrupting Capacity
120/208 10,000 AIC
277/480 14,000 AIC
 - 5. [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.]
- C. Mounting:
 - 1. The front faces of all circuit breakers shall be flush with each other.
 - 2. Tripped indication shall be clearly shown by the breaker handle taking a position between "ON" and "OFF".
 - 3. Provisions for additional breakers shall be such that no additional connectors will be required to add breakers.
 - 4. 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] [plug-in] on to the main bus for 208/120 volt panels.
 - 5. All 2 and 3-pole breakers shall have common trips.
 - 6. Circuit breakers shall be replaceable without disturbing adjacent units. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - 7. Multi-pole units enclosed in a single housing or factory assembled to operate as a single unit.
 - 8. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in [on] [off] [on or off] position.
 - 9. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- D. Overcurrent Protective Devices in Existing Panels:
 - 1. Circuit breakers installed in existing building panelboards shall be from the same manufacturer as and compatible with the existing panelboard and shall have an interrupting rating equal to or greater than the interrupting rating of the existing breakers installed in the panelboard.]
- E. Molded-Case Circuit Breaker (MCCB):

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 3. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- F. Solid State Trip Unit Circuit Breakers:
1. Distribution panel circuit breakers [400 ampere frame and above and all emergency power system distribution panel circuit breakers] 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]
- G. 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".
- H. Fused Switch: 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.NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."
- 2.5 ELECTRONIC-GRADE PANELBOARDS
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Current Technology; a subsidiary of Danahar Corporation.
 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 4. Liebert Corporation.

5. Siemens Energy & Automation, Inc.
 6. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1; with factory-installed, integral SPD; labeled by an NRTL for compliance with UL 67 after installing SPD.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- D. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- E. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- F. Busses:
1. Copper phase and neutral busses; 200 percent capacity neutral bus and lugs.
 2. Copper equipment and isolated ground busses.
- G. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, plug-in or bolt-on, solid-state, parallel-connected, (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating complying with UL 1449, 3rd edition, and matching or exceeding the panelboard short-circuit rating, redundant suppression circuits, with individually fused metal-oxide varistors.

PART 3 - EXECUTION - Refer to Division 26 specification section for characteristics for surge protective devices.

3.1 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver or install panelboard interiors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Deliver distribution panels and panelboards in factory-fabricated water-resistant wrapping.
- C. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- D. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation, unless stored in dried-in, conditioned space.
- E. Handle panelboards carefully to avoid damage to material component, enclosure and finish.
- F. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- G. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.
- B. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- C. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- D. Install filler plates in unused spaces.
- E. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
- F. Arrange conductors in gutters into groups and bundle and wrap with wire ties after testing for load balance.
- G. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 specification section for identifying electrical systems.
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with Division 26 specification section for identifying electrical systems.
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with Division 26 specification section for identifying electrical systems.

3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Test continuity of each circuit.
 - 2. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 5. Perform the following infrared scan tests and inspections and prepare reports:

- a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- B. Panelboards will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 specification section for the overcurrent protective device coordination study."
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

END OF SECTION

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Twist-locking receptacles.
 - 3. Receptacles with integral surge-suppression units.
 - 4. Isolated-ground receptacles.
 - 5. Hospital-grade receptacles.
 - 6. Tamper-resistant receptacles.
 - 7. Weather-resistant receptacles.
 - 8. Snap switches and wall-box dimmers.
 - 9. Solid-state fan speed controls.
 - 10. Wall-switch and exterior occupancy sensors.
 - 11. Communications outlets.
 - 12. Pendant cord-connector devices.
 - 13. Cord and plug sets.
 - 14. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

2. Cord and Plug Sets: Match equipment requirements.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.

1.6 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Service/Power Poles: [One for every 10] <Insert quantities>, but no fewer than [one] <Insert number>.
 2. Floor Service-Outlet Assemblies: [One for every 10] <Insert quantities>, but no fewer than [one] <Insert number>.
 3. Poke-Through, Fire-Rated Closure Plugs: [One for every five] <Insert quantities> floor service outlets installed, but no fewer than [two] <Insert number>.
 4. TVSS Receptacles: [One for every 10] <Insert quantities> of each type installed, but no fewer than [two of each type] <Insert number>.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 3. Leviton Mfg. Company Inc. (Leviton).
 4. Pass & Seymour/Legrand (Pass & Seymour).

- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
 - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 - 2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; 5351 (single), CR5362 (duplex).
 - b. Hubbell; HBL5351 (single), HBL5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5361 (single), 5362 (duplex).
- B. Hospital-Grade, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.
 - 1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; 8310 (single), 8300 (duplex).
 - b. Hubbell; HBL8310 (single), HBL8300 (duplex).
 - c. Leviton; 8310 (single), 8300 (duplex).
 - d. Pass & Seymour; 8301 (single), 8300H (duplex).
 - 2. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
- C. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; IG5362RN.
 - b. Hubbell; IG5362.

- c. Leviton; 5362-IG.
 - d. Pass & Seymour; IG5362.
 2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
- D. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.
 1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; TR8300.
 - b. Hubbell; DR15WHITR.
 - c. Leviton; 8300-SGG.
 - d. Pass & Seymour; TR63H.
 2. Description: Labeled shall comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

2.4 GFCI RECEPTACLES

- A. General Description:
 1. Straight blade, [feed] [non-feed]-through type.
 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
 1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; VGF20.
 - b. Hubbell; GFR5352L.
 - c. Pass & Seymour; 2095.
 - d. Leviton; 7590.
- C. Tamper-Resistant GFCI Convenience Receptacles, 125 V, 20 A:
 1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Hubbell; GFTR20.
 - b. Pass & Seymour; 2095TR.
- D. Hospital-Grade, Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.

1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; VGFH20.
 - b. Hubbell; HFR8300HL.
 - c. Leviton; 7899-HG.
 - d. Pass & Seymour; 2095HG.

2.5 TVSS RECEPTACLES

- A. General Description: Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 1449, and FS W-C-596, with integral TVSS in line to ground, line to neutral, and neutral to ground.
 1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
 2. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."
- B. Duplex TVSS Convenience Receptacles:
 1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; 5362BLS.
 - b. Hubbell; HBL5362SA.
 - c. Leviton; 5380.
 - d. Pass & Seymour; 5362BLSP.
 2. Description: Straight blade, 125 V, 20 A; NEMA WD 6 Configuration 5-20R.
- C. Isolated-Ground, Duplex Convenience Receptacles:
 1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; IG5362BLS.
 - b. Hubbell; IG5362SA.
 - c. Leviton; 5380-IG.
 - d. Pass & Seymour; IG5362BLSP.
 2. Description:
 - a. Straight blade, 125 V, 20 A; NEMA WD 6 Configuration 5-20R.
 - b. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
- D. Hospital-Grade, Duplex Convenience Receptacles: Comply with UL 498 Supplement sd.
 1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:

- a. Cooper; 8300BLS.
 - b. Hubbell; HBL8362SA.
 - c. Leviton; 8380.
 - d. Pass & Seymour; 8300BLSP.
2. Description: Straight blade, 125 V, 20 A; NEMA WD 6 Configuration 5-20R.
 3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 4. Comply with NFPA 70.
- E. Isolated-Ground, Hospital-Grade, Duplex Convenience Receptacles:
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; IG8300HGBLS.
 - b. Hubbell; IG8362SA.
 - c. Leviton; 8380-IG.
 - d. Pass & Seymour; IG8300BLSP.
 2. Description:
 - a. Straight blade, 125 V, 20 A; NEMA WD 6 Configuration 5-20R.
 - b. Comply with UL 498 Supplement sd.
 - c. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
- 2.6 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES
- A. [Available]Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [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]:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 - a. Cooper Crouse-Hinds.
 - b. EGS/Appleton Electric.
 - c. Killark; Division of Hubbell Inc.
- 2.7 TWIST-LOCKING RECEPTACLES
- A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; CWL520R.
 - b. Hubbell; HBL2310.
 - c. Leviton; 2310.

d. Pass & Seymour; L520-R.

B. Isolated-Ground, Single Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; IGL520R.
 - b. Hubbell; IG2310.
 - c. Leviton; 2310-IG.
 - d. Pass & Seymour; IG4700.
2. Description:
 - a. Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
 - b. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.8 PENDANT CORD-CONNECTOR DEVICES

A. Description:

1. Matching, locking-type plug and receptacle body connector.
2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.9 CORD AND PLUG SETS

A. Description:

1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.10 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Single Pole:
 - b. Cooper; AH1221.
 - c. Hubbell; HBL1221.
 - d. Leviton; 1221-2.
 - e. Pass & Seymour; CSB20AC1.
 - f. Two Pole:
 - g. Cooper; AH1222.
 - h. Hubbell; HBL1222.
 - i. Leviton; 1222-2.
 - j. Pass & Seymour; CSB20AC2.
 - k. Three Way:
 - l. Cooper; AH1223.
 - m. Hubbell; HBL1223.
 - n. Leviton; 1223-2.
 - o. Pass & Seymour; CSB20AC3.
 - p. Four Way:
 - q. Cooper; AH1224.
 - r. Hubbell; HBL1224.
 - s. Leviton; 1224-2.
 - t. Pass & Seymour; CSB20AC4.

- C. Pilot-Light Switches, 20 A:
 1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; AH1221PL for 120 and 277 V.
 - b. Hubbell; HBL1201PL for 120 and 277 V.
 - c. Leviton; 1221-LH1.
 - d. Pass & Seymour; PS20AC1RPL for 120 V, PS20AC1RPL7 for 277 V.
 2. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."

- D. Key-Operated Switches, 120/277 V, 20 A:
 1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; AH1221L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
 - d. Pass & Seymour; PS20AC1-L.
 2. Description: Single pole, with factory-supplied key in lieu of switch handle.

- E. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.
 1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:

- a. Cooper; 1995.
 - b. Hubbell; HBL1557.
 - c. Leviton; 1257.
 - d. Pass & Seymour; 1251.
- F. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; 1995L.
 - b. Hubbell; HBL1557L.
 - c. Leviton; 1257L.
 - d. Pass & Seymour; 1251L.

2.11 DECORATOR-STYLE DEVICES

- A. Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; 6252.
 - b. Hubbell; DR15.
 - c. Leviton; 16252.
 - d. Pass & Seymour; 26252.
- B. Tamper-Resistant Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; TR6252.
 - b. Hubbell; DR15TR.
 - c. Pass & Seymour; TR26252.
 2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section.
- C. Tamper-Resistant and Weather-Resistant Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; TWRBR15.
 - b. Hubbell; DR15TR.
 - c. LevitonTRW15.
 - d. Pass & Seymour; TRW26252.

2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section, when installed in wet and damp locations.
- D. GFCI, [Feed] [Non-Feed]-Through Type, Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A.
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; VGF15.
 - b. Hubbell; GF15LA.
 - c. Leviton; 8599.
 - d. Pass & Seymour; 1594.
- E. GFCI, Tamper-Resistant and Weather-Resistant Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A.
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; TWRVGF15.
 - b. Hubbell; GFTR15.
 - c. Pass & Seymour; 1594TRWR.
 2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section.
- F. Toggle Switches, Square Face, 120/277 V, 15 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; 7621 (single pole), 7623 (three way).
 - b. Hubbell; DS115 (single pole), DS315 (three way).
 - c. Leviton; 5621-2 (single pole), 5623-2 (three way).
 - d. Pass & Seymour; 2621 (single pole), 2623 (three way).
- G. Lighted Toggle Switches, Square Face, 120 V, 15 A: Comply with NEMA WD 1 and UL 20.
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; 7631 (single pole), 7633 (three way).
 - b. Hubbell; DS120IL (single pole), DS320 (three way).
 - c. Leviton; 5631-2 (single pole), 5633-2 (three way).
 - d. Pass & Seymour; 2625 (single pole), 2626 (three way).
 2. Description: With neon-lighted handle, illuminated when switch is "off."

2.12 RESIDENTIAL DEVICES

- A. Residential-Grade, Tamper-Resistant Convenience Receptacles, 125 V, 15 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, and UL 498.
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; TR270.
 - b. Hubbell; RR155TR.
 - c. Leviton; T5320.
 - d. Pass & Seymour; TR62.
 2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section.
- B. Weather-Resistant and Tamper-Resistant Convenience Receptacles, 125 V, 15 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, and UL 498.
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; TWR270.
 - b. Hubbell; RR155WRTR.
 - c. Leviton; TWR15.
 - d. Pass & Seymour; 3232TRWR.
 2. Description: Labeled to comply with NFPA 70, "Receptacles, Cord Connectors, and Attachment Plugs (Caps)" Article, "Tamper-Resistant Receptacles in Dwelling Units" Section, when installed in wet and damp locations.
- C. Fan Speed Controls:
1. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters.
 2. Comply with UL 1917.
 3. Continuously adjustable [slider] [toggle switch] [rotary knob], [5 A] [1.5 A].
 4. Three-speed adjustable [slider] [rotary knob], 1.5 A.
- D. Telephone Outlet:
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Cooper; 3560-6.
 - b. Leviton; 40649.
 2. Description: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with [Category 5e] <Insert category>. Comply with UL 1863.
- E. Combination TV and Telephone Outlet:
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:

- a. Cooper; 3562.
- b. Leviton; 40159.
2. Description: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with [Category 5e] <Insert category>. Comply with UL 1863.

2.13 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable [slider] [toggle switch] [rotary knob]; with single-pole or three-way switching. Comply with UL 1472.
- C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
 1. 600 W; dimmers shall require no derating when ganged with other devices.[Illuminated when "off."]
- D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.14 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 1. Plate-Securing Screws: Metal with head color to match plate finish.
 2. Material for Finished Spaces: [Steel with white baked enamel, suitable for field painting] [Smooth, high-impact thermoplastic] [0.035-inch- (1-mm-) thick, satin-finished, Type 302 stainless steel] [0.04-inch- (1-mm-) thick, brushed brass with factory polymer finish] [0.05-inch- (1.2-mm-) thick, anodized aluminum] [0.04-inch- (1-mm-) thick steel with chrome-plated finish].
 3. Material for Unfinished Spaces: [Galvanized steel] [Smooth, high-impact thermoplastic].
 4. Material for Damp Locations: [Thermoplastic] [Cast aluminum] with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant[, die-cast aluminum] [thermoplastic] with lockable cover.

2.15 FLOOR SERVICE FITTINGS

- A. Type: Modular, [flush-type] [flap-type] [above-floor], dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: [Rectangular] [Round], [die-cast aluminum] [solid brass] with satin finish.
- D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

- E. Voice and Data Communication Outlet: [Blank cover with bushed cable opening] [Two modular, keyed, color-coded, RJ-45 jacks for UTP cable complying with requirements in Section 271500 "Communications Horizontal Cabling."]

2.16 POKE-THROUGH ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [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]:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 1. Hubbell Incorporated; Wiring Device-Kellems.
 2. Pass & Seymour/LeGrand.
 3. Square D/Schneider Electric.
 4. Thomas & Betts Corporation.
 5. Wiremold/LeGrand.

- C. Description:

1. Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
2. Comply with UL 514 scrub water exclusion requirements.
3. Service-Outlet Assembly: [Pedestal type with services indicated] [Flush type with two simplex receptacles and space for two RJ-45 jacks] [Flush type with four simplex receptacles and space for four RJ-45 jacks] complying with requirements in Section 271500 "Communications Horizontal Cabling."
4. Size: Selected to fit nominal [3-inch (75-mm)] [4-inch (100-mm)] cored holes in floor and matched to floor thickness.
5. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
6. Closure Plug: Arranged to close unused [3-inch (75-mm)] [4-inch (100-mm)] cored openings and reestablish fire rating of floor.
7. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of [two] [four], four-pair cables that comply with requirements in Section 271500 "Communications Horizontal Cabling."

2.17 PREFABRICATED MULTIOUTLET ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [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]:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 1. Hubbell Incorporated; Wiring Device-Kellems.
 2. Wiremold/LeGrand.

- C. Description:
1. Two-piece surface metal raceway, with factory-wired multioutlet harness.
 2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- D. Raceway Material: [Metal, with manufacturer's standard finish] [PVC].
- E. Multioutlet Harness:
1. Receptacles: 15-A, 125-V, NEMA WD 6 Configuration 5-15R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
 2. Receptacle Spacing: [6 inches (150 mm)] [9 inches (230 mm)] [12 inches (300 mm)] [18 inches (460 mm)].
 3. Wiring: No. 12 AWG solid, Type THHN copper, [single circuit] [two circuit, connecting alternating receptacles].

2.18 SERVICE POLES

- A. Description:
1. Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
 2. Poles: Nominal 2.5-inch- (65-mm-) square cross section, with height adequate to extend from floor to at least 6 inches (150 mm) above ceiling, and with separate channels for power wiring and voice and data communication cabling.
 3. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
 4. Finishes: [Manufacturer's standard painted finish and trim combination] [Satin-anodized aluminum].
 5. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, four-pair, Category 3 or Category 5 voice and data communication cables.
 6. Power Receptacles: Two duplex, 20-A, straight-blade receptacles complying with requirements in this Section.
 7. Voice and Data Communication Outlets: [Blank insert with bushed cable opening] [Two RJ-45 jacks] [Four RJ-45 jacks] complying with requirements in Section 271500 "Communications Horizontal Cabling."

2.19 FINISHES

- A. Device Color:
1. Wiring Devices Connected to Normal Power System: [Almond] [Black] [Brown] [Gray] [Ivory] [White] [As selected by Architect] <Insert color> unless otherwise indicated or required by NFPA 70 or device listing.
 2. Wiring Devices Connected to Emergency Power System: [Red] <Insert color>.
 3. TVSS Devices: Blue.
 4. Isolated-Ground Receptacles: [Orange] [As specified above, with orange triangle on face].
- B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
 - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
 - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 - 8. Tighten unused terminal screws on the device.
 - 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles [up] [down], and on horizontally mounted receptacles to the [right] [left].
 2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Dimmers:
1. Install dimmers within terms of their listing.
 2. Verify that dimmers used for fan speed control are listed for that application.
 3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
- H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.
- 3.2 GFCI RECEPTACLES
- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.
- 3.3 IDENTIFICATION
- A. Comply with Section 260553 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with [black] [white] [red]-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
- 3.4 FIELD QUALITY CONTROL
- A. Perform the following tests and inspections[with the assistance of a factory-authorized service representative]:
1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
 2. Test Instruments: Use instruments that comply with UL 1436.
 3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- B. Tests for Convenience Receptacles:
1. Line Voltage: Acceptable range is 105 to 132 V.
 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.

3. Ground Impedance: Values of up to 2 ohms are acceptable.
 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Test straight-blade [convenience outlets in patient-care areas] [hospital-grade convenience outlets] for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz. (115 g).
- D. Wiring device will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

- A. Section Includes:
 - 1. Cartridge fuses rated 600-V ac and less for use in [control circuits] [enclosed switches] [panelboards] [switchboards] [enclosed controllers] [and] [motor-control centers].
 - 2. Spare-fuse cabinets.

1.3 ACTION SUBMITTALS

- A. Shop Drawing submittals shall include, but not be limited to, the following:
 - 1. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - a. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - 1) For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - 2) Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 - b. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - c. Current-limitation curves for fuses with current-limiting characteristics.
 - d. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - e. Coordination charts and tables and related data.
 - f. Fuse sizes for elevator feeders and elevator disconnect switches.
- B. Closeout Submittal
 - 1. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 2. Ambient temperature adjustment information.

1.4 SPARE MATERIALS

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

1. Fuses: Equal to [10] percent of quantity installed for each size and type, but no fewer than [three] of each size and type.
2. Install in Spare Fuse Cabinet.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Comply with UL 248-11 for plug fuses.

1.6 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C) , apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.7 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide one of the following:
 1. Cooper Bussmann, Inc.
 2. Edison Fuse, Inc.
 3. Ferraz Shawmut, Inc.
 4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 SPARE FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
 - 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
 - 2. Finish: Gray, baked enamel.
 - 3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
 - 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Service Entrance: [Class L, fast acting] [Class L, time delay] [Class RK1, fast acting] [Class RK1, time delay].
 - 2. Feeders: Class RK5, time delay
 - 3. Motor Branch Circuits: [Class RK1] [Class RK5], time delay.
 - 4. Other Branch Circuits: [Class RK1, time delay] [Class RK5, time delay] [Class J, fast acting] [Class J, time delay].
 - 5. Control Circuits: Class CC, [fast acting] [time delay].

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s) in main electrical room unless otherwise indicated on drawings.

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Non-fusible switches.
 - 3. Shunt trip switches.
 - 4. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Shop Drawings: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
- B. Closeout Submittals:
 - 1. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 - 2. Altitude: Not exceeding 6600 feet (2010 m).

1.7 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
 - 5. Cooper Industries; Bussman
- B. Type HD, Heavy Duty, Single Throw, [240] [600]-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

- D. Type HD, Heavy Duty, Double Throw, [240] [600]-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 4. Lugs: Compression type, suitable for number, size, and conductor material.
 - 5. Service-Rated Switches: Labeled for use as service equipment.
 - 6. Accessory Control Power Voltage: Remote mounted and powered; [24-V ac] [120-V ac] [208-V ac] [240-V ac] [6-V dc] [12-V dc] [24-V dc].

2.2 NON-FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
 - 5. Cooper Industries; Bussman
- B. Type HD, Heavy Duty, Single Throw, [240] [600]-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Double Throw, [240] [600]-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 4. Lugs: Compression type, suitable for number, size, and conductor material.
 - 5. Accessory Control Power Voltage: Remote mounted and powered; [24-V ac] [120-V ac] [208-V ac] [240-V ac] [6-V dc] [12-V dc] [24-V dc].

2.3 MOLDED-CASE CIRCUIT BREAKERS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
- 2.4 MOLDED-CASE SWITCHES
- A. Manufacturers: Subject to compliance with requirements, provide one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Features and Accessories:
1. Standard frame sizes and number of poles.
 2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
- 2.5 ENCLOSURES
- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
1. Indoor, Dry and Clean Locations: NEMA 250, Type 1 .
 2. Outdoor Locations: NEMA 250, Type 3R .
 3. Kitchen Wash-Down Areas: NEMA 250, Type 4X , .
 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4 .
 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 6. Hazardous (Classified) Areas Indicated on Drawings: NEMA 250, [Type 7] [Type 9].

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Refer to testing requirements specified in Section 260001 "Basic Requirements for Electrical"
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

END OF SECTION

SECTION 265600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide all materials and equipment, and do all work required for site lighting as indicated on the Drawings and as specified herein.
 - 1. All public realm lighting shall conform to TXDOT, San Antonio Department of Parks and Recreation and City of San Antonio requirements and standards.

1.2 RELATED WORK

- A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:
 - 1. Section 033010, CAST-IN-PLACE CONCRETE - SITEWORK.
 - 2. Section 323400, FABRICATED BRIDGES.

1.3 DEFINITIONS

- A. Fixture: A complete lighting unit. Fixtures include a lamp or lamps and parts required to distribute the light, position and protect lamps, and connect lamps to the power supply.
- B. Lighting Unit: A fixture, or an assembly of fixtures with a common support, including a pole or bracket plus mounting and support accessories.
- C. Luminaire: A fixture.
- D. Driver: Power supply for low voltage lighting units.

1.4 SUBMITTALS

- A. Product data describing fixtures, lamps, ballasts, poles, and accessories. Arrange product data for fixtures in order of fixture designation. Include data on features, poles, accessories, and the following:
 - 1. Outline drawings of fixtures and poles indicating dimensions and principal features.
 - 2. Electrical ratings and photometric data with certified results of independent laboratory tests
- B. Shop drawings of each site lighting fixture, mounting component, and accessories shall be submitted. Drawings shall indicate driver locations for all lighting units, size, dimensions, materials, finish, connections, sleeving, wiring diagrams, foundations and anchorage, and all other items required for complete lighting installation.
- C. Product certifications signed by manufacturers of lighting units certifying that their

products comply with specified requirements.

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 70 "National Electrical Code" for components and installation.
- B. Comply with ANSI C2, "National Electrical Safety Code."
- C. Listing and Labeling: Provide fixtures and accessories that are listed and labeled for their indicated use and location on the Project.
 - 1. Special Listing and Labeling: Provide lighting units for use under water that are specifically listed and labeled for such use.
 - 2. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.
 - 3. Listing and Labeling Agency Qualification: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- D. Manufacturers' Qualifications: Firms experienced in manufacturing lighting units that are similar to those indicated for this Project and that have a record of successful in-service performance.
- E. Light fixtures shall conform to all Dark Sky Requirements as defined in The "IES" (Illuminating Engineering Society of North America) Lighting Handbook, most recent edition.

1.6 STORAGE AND HANDLING OF POLES

- A. General: Store poles on decay-resistant treated skids at least 1 ft. above grade and vegetation. Support pole to prevent distortion and arrange to provide free air circulation.
- B. Metal Poles: Retain factory-applied pole wrappings until just before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

PART 2 - PRODUCTS

2.1 FIXTURE COMPONENTS, GENERAL

- A. Metal Parts: Free from burrs and sharp edges and corners.
- B. Sheet Metal Components: Corrosion-resistant aluminum, except as indicated. Form and support to prevent warping and sagging.
- C. Housings: Rigidly formed, weather and light tight enclosures that will not warp, sag, or deform in use. Provide filter/ breather for enclosed fixtures.
- D. Doors, Frames, and Other Internal Access Provisions: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in the operating position. Provide for door removal for cleaning or replacing lens. Arrange for door opening to disconnect ballast.

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- E. Exposed Hardware Material: Stainless steel.
 - F. Reflecting Surfaces: Minimum reflectance's as follows, except as otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
 - G. Plastic Parts: Resistant to yellowing and other changes due to aging and exposure to heat and UV radiation.
 - H. Lenses and Refractors: Materials as indicated. Use heat and aging resistant, resilient gaskets to seal and cushion lens and refractor mounting in fixture doors.
 - I. Weatherproof Outlet: shall be Hubbell Taymac MX6200, Two Gang, In-Use Cover, supplied by Global Industrie.com. Color shall be Gray. Or as specified on the drawings.
 - 1. Patented quick fit key-hole mounting system allows cover installation under a minute
 - 2. Pre-configured for GFCI with patented knock-out technology for alternate devices
 - 3. Extra duty rated
 - 4. Vertical mount
 - 5. 55-in-1 Configurations
 - 6. NEMA 3R compliant

2.2 FIXTURES

- A. Refer to drawings for fixture types and locations.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- A. Light fixtures shall be installed plumb, square, level, and secure in conformance with the Drawings and approved shop drawings, and in strict accordance with manufacturer's printed instructions.
- B. The Contractor shall take all necessary precautions during installation of light fixtures to protect finished surfaces from denting, scratching, breakage, and other damages.

3.2 CONCRETE SUPPORT

- A. Construct concrete cradles and collars with 3000-pound, 28-day concrete conforming to Section 033010, CAST-IN-PLACE CONCRETE - SITEWORK. Comply with details and manufacturer's recommendations for reinforcing, anchor bolts, nuts, and washers.
- B. Fixture Attachment: Fasten to indicated structural supports.

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- C. Lamp fixtures with indicated lamps according to manufacturer's instructions. Replace malfunctioning lamps.
- 3.3 GROUNDING
- A. Ground fixtures according to manufacturer's printed instructions.
- 3.4 LIGHT FIXTURES
- A. Lights shall be installed at locations indicated on the Drawings and in strict accordance with manufacturer's printed instructions.
- 3.5 WALL LIGHTS
- A. Wall lights shall be installed in cast in place concrete walls or precast concrete Tree Island Supports or wood decking, with their drivers to be located on building interior or in above grade water proof boxes. Refer to architecture drawings.
- 3.6 FIELD QUALITY CONTROL
- A. Inspect installed units for damage.
 - B. Provide advance notice of dates and times for field tests.
 - C. Provide instruments to make and record test results.
 - D. Tests: Verify normal operation of lighting units after installing fixtures and energizing circuits with normal power source. Include the following:
 - 1. Check for excessively noisy ballasts.
 - 2. Check for uniformity of illuminations.
 - 3. Written report of tests indicating actual illumination results.
 - E. Replace or repair damaged and malfunctioning units and retest.
- 3.7 ADJUSTING AND CLEANING
- A. Adjust in the field to optimize lighting intent, minimize hot spots, and ensure lighting does not impact neighbors
 - B. Clean components on completion of installation. Use methods and materials recommended by manufacturer.

END OF SECTION

PART 1 - GENERAL

1.1 PROJECT SUMMARY

- A. Scope: Successful bidder shall provide, install, configure, and provide warranty service for technology systems described herein.

1.2 RELATED DOCUMENTS

- A. Documents: Provisions of General Conditions, Supplementary Conditions, and the sections included under Procurement & Contract Requirements are included as part of this section as though bound herein.

1.3 RELATED WORK

- A. Section 27 05 00 – Communications General Requirements
- B. Section 27 05 23 – Pathways for Technology Systems
- C. Section 27 05 26 – Grounding and Bonding for Technology Systems
- D. Section 27 11 00 – Communications Equipment Rooms
- E. Section 27 13 00 – Communications Backbone Cabling
- F. Section 27 15 00 – Communications Horizontal Cabling
- G. Section 27 16 00 – Communications Connecting Cords
- H. Section 27 18 00 – Communications Labeling and Identification

1.4 DEFINITIONS

- A. Approved or Approval: Where approval is called for, only persons with the authorized authority may grant approval. Owner reserves all rights to govern over and grant approval and will appoint authority of agents acting on their behalf.
- B. As Required: Contractor shall provide the quantity of said item that is necessary. Owner and Consultant reserve the right to make the final determination of necessary quantities to provide for a complete system.
- C. Basis of Design: The documentation of the concepts, calculations, decisions, and product selections used to meet the Owner's project requirements. These Consultant produced documents are not shop drawings. Product selections depict minimum functionality and overall quality and are open to substitution requests.
- D. Consultant: True North Consulting Group.
- E. Copyright: ©1984-2021 True North Consulting Group.
- F. Contractor: The qualified party responsible to provide all items and perform services as described within these documents. The Contractor referred to within a specific specification section shall be the successful qualified party contracted to perform and complete that work.

- G. Documents: The complete package of Bid and Contract Requirements, General Technology Requirements, related Division 27 sections, drawings, schedules, and addenda that make up this Request for Bid.
- H. End-User: Individual(s) who will ultimately operate the completed system.
- I. ETR: Existing to Remain. Item is to remain in current location and maintain current functionality.
- J. Furnish: To supply and deliver to project site, ready for installation.
- K. Install: To place in a position of service or use.
- L. NIC: Not in Contract. Item will be the responsibility of others.
- M. Notice to Proceed: Formal communication from Owner to Contractor stating the date the Contractor can begin work subject to the conditions of the contract. The performance time of the contract starts from the Notice to Proceed date.
- N. OFCI: Owner Furnished Contractor Installed. Item will be provided by Owner and shall be installed by Contractor.
- O. OFE: Owner Furnished Equipment. Item will be provided and integrated by Owner.
- P. OFOI: Owner Furnished Owner Installed. Item will be provided and installed by Owner.
- Q. Owner: The party named in the Procurement and Contract Requirements as the advertising party.
- R. Provide: To furnish and install, complete and ready for intended use.
- S. Substantial Completion: The stage in the progress of installation when the systems described herein are sufficiently complete, in accordance with the Contract Documents, so that the Owner can utilize such systems for their complete intended use.
- T. Turnkey: Of or involving the provision of a complete product or service that is ready for immediate use.
- U. Work: The provision of products and/or services to meet the requirements specified in these documents.

1.5 REFERENCE STANDARDS AND CODES

- A. Standards and other procedures referenced by this bid package are as follows:
 - 1. ADA – Americans with Disabilities Act of 2010
www.ada.gov/2010ADASTandards_index.htm
 - 2. AIA – American Institute of Architects
www.aia.org
 - 3. ANSI – American National Standards Institute
www.ansi.org
 - 4. ASTM – American Society of Testing and Materials
www.astm.org
 - 5. BICSI – Building Industry Consulting Service International, Inc.
(RCDD Standards)
www.bicsi.org

6. CFR – Code of Federal Regulations
www.gpo.gov/fdsys/browse/collectionCfr.action?collectionCode=CFR
(Available from the Government Printing Office)
(Material is usually first published in the Federal Register)
 7. U.S. Copyright Law, December 2011
www.copyright.gov/title17
 8. ECIA – Electronic Components Industry Association
ESC – EIA Standards Council
www.eciaonline.org
 9. IACS – International Annealed Copper Standard
www.ndt-ed.org/GeneralResources/IACS/IACS.htm
 10. IEC – International Electrotechnical Commission
www.iec.ch
 11. IEEE – Institute of Electrical and Electronics Engineers
standards.ieee.org
 12. ISO – International Organization for Standardization
www.iso.org
 13. ITU-T – International Telecommunication Union – Telecommunication
www.itu.int
 14. NEC – National Electrical Code (NFPA 70)
maintained by NFPA – National Fire Protection Association
www.nfpa.org
 15. NECA – National Electrical Contractors Association
www.necanet.org
 16. NEMA – National Electrical Manufacturers' Association
www.nema.org
 17. OSHA – Occupational Safety and Health Administration
(U.S. Department of Labor, OSHA)
www.osha.gov
 18. TIA – Telecommunications Industry Association
www.tiaonline.org/standards
 19. UL – Underwriters' Laboratories
www.ul.com
- B. Standards: Referenced standards and/or procedures shall be binding on the Contractor and work shall be judged against such standards and procedures unless otherwise stated in writing.
- C. Local/State Codes: Contractor shall comply with all local and state code requirements as determined by the authority having jurisdiction (AHJ).
- D. Owner Standards: Contractor shall obtain and abide by all published Owner standards as they pertain to the work described herein.
- E. Contractor shall use the latest versions of all standards and codes unless otherwise directed by the authority having jurisdiction (AHJ) or expressly noted herein.

1.6 QUALIFICATIONS

- A. Refer to related sections for specific requirements.

1.7 PERMITS AND INSPECTIONS

- A. Responsibility: Obtain permits and inspections required for the work. Contractor is responsible for all permit and inspection costs.
- B. Performance: Perform tests required herein, or as may be reasonably required to demonstrate conformance with the specifications or with the requirements of any legal authority having jurisdiction.
- C. Review: Obtain approvals from authorities responsible for enforcement of applicable codes and regulations to establish that the work is in compliance with all requirements of reference codes indicated herein and required by the appropriate jurisdiction. Make corrections, changes or additions as required and deliver certificates of acceptance, operation, and/or compliance with the Operation and Maintenance Manuals described herein.

1.8 DRAWINGS AND BASIS OF DESIGN

- A. General: Work, equipment, or material delineated on any drawing in this package is expected to be provided by Contractor unless noted otherwise.
- B. Interpretation: Work shall be installed in accordance with the basis of design diagrammatically expressed on the drawings and described in the written specifications and equipment schedule(s). Contractor shall not make limiting interpretation that provides for incomplete work or a non-functioning system.

1.9 PRODUCT SUBSTITUTION PROCEDURES

- A. Requests for Substitutions: Should the Contractor request a change in the material that is to be supplied, from that which was specified in the contract, the Contractor shall provide the Owner and the Consultant with a written request for said change.
- B. Substitutions for Non-specified Products: Where no product specification is provided, Contractor may use manufacturer's specification for the identified product as a guide for suggesting appropriate substitutions.
- C. Requirements: The Request for Substitution shall include:
 - 1. Reason for substitution.
 - 2. Material data sheets for both the proposed item(s) and the item(s) to be replaced.
 - 3. Any cost impact to the Owner.
- D. Changes: Proposed changes to Contract Documents shall be clearly identified in the pre-construction submittals.
- E. Approval: The Owner may approve or deny any Requests for Substitution. The Owner reserves the right to govern over and proclaim whether proposed products are equal to the specifications. The Contractor shall not procure any substitute materials until the Owner has approved and signed the Request for Substitution and passed copies to the Contractor and the Consultant. Any procurement or work performed prior to this approval is at the Contractor's own risk.

- F. Deviation: Products provided or installed that deviate from the products specified in make, model, color, or other significant characteristic (i.e., non-approved substitutions) shall be removed and replaced with specified products at no additional expense to Owner.

1.10 SOFTWARE

- A. Versions: Consultant used the following software versions for this project:
 - 1. Autodesk AutoCAD MEP 2018

1.11 SUBMITTAL CONDITIONS

- A. The Contractor shall not consider the Consultant or Owner's review of submittals to be exhaustive or complete in every detail. Approval of shop drawings or submittals including substitutions indicates only the acceptance of the Contractor's apparent intent to comply with general design or method of construction and quality as specified. The finished product shall meet functional requirements, operations, arrangements, and quantities and comply with the contract documents unless specifically approved otherwise.
- B. The Contractor shall be held responsible for delivery of systems as specified. Any errors or omissions in the submittals shall not relieve Contractor of responsibility to deliver complete systems as specified.

1.12 PRE-CONSTRUCTION PROCEDURES

- A. Pre-Construction Submittal Meeting: Contractor shall schedule web conference (WebEx or similar) with Consultant to review basis of design and submittal expectations.
- B. Prior to Work: Pre-construction submittals shall be provided to Consultant with appropriate promptness as to cause no delay to the work.
- C. Project Timeline: Project timeline will not be altered due to lateness of submittals. Contractor is bound to deliver a timely, complete, and finished project as stipulated in their contract and specified herein.
- D. Format and Distribution: Contractor shall provide one (1) electronic copy in PDF format to Consultant of all pre-construction submittals. The Contractor shall provide hard copies sets as required up to five (5) sets.
- E. Provision: Contractor shall submit pre-construction submittals including any corrections or additions to Consultant prior to the procurement of equipment or commencement of work.
- F. Review: Pre-construction submittals shall be received and formally approved by Consultant prior to the procurement of material or the commencement of work. Any procurement or work performed prior to this approval is at Contractor's own risk.
- G. Failure to Provide: The failure of Contractor to provide pre-construction submittals as required herein may result in the withholding of payment for work and/or the cancellation of the contract.

1.13 PRE-CONSTRUCTION SUBMITTALS

- A. Pre-construction submittals are intended to document the details of installation. Exact copies of original drawings and specifications are not acceptable as pre-construction submittal drawings. Consultant schematic diagrams describe the basis of design as defined herein.
- B. Contractor shall provide to Consultant the following pre-construction submittals for approval in addition to specific requirements identified in subsequent sections.

1. Qualifications: Shall include documentation of all required qualifications.
2. Shop Drawings:
 - a. Title: Each drawing shall have a descriptive title and all subparts of each drawing shall have unique identifiers.
 - b. Floor Plans: Shall include device locations, Contractor provided furniture and installation notes.
 - c. System Drawings: Shall include functional diagrams for each system detailing system flow including all equipment, routing, inputs/outputs, wiring signal type, cable identification detail, connectors, adapters, intra/inter-rack power distribution, installation notes and any other information required to convey the complete turnkey system design.
 - d. Equipment Rack and Cabinet Elevations: Shall include placement of all mounted equipment.
 - e. Structurally Mounted Elements: Shall include both plan view of placement as well as a detail of structural mounting techniques to be used.
 - f. Furniture: Shall include all Contractor provided furniture showing dimensional drawings, cable management and finishes with samples for Owner approval.
3. Product Data:
 - a. Equipment Schedules: Shall include manufacturers, part numbers, quantities and unit pricing.
 - b. Product Cut Sheets: Shall identify (highlight, arrow, etc.) actual part numbers to be utilized including but not limited to equipment, mounting hardware, cabling, connectors, software and power distribution equipment.
4. Manufacturer's Recommendations:
 - a. Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, copies of these recommendations shall be provided prior to installation. Installation of the items will not be allowed to proceed until the recommendations are received and approved.

1.14 PRE-INSTALLATION PROCEDURES

- A. Refer to individual sections for additional information.

1.15 CONSTRUCTION PROGRESS PROCEDURES

- A. Meeting Attendance: Contractor is required to attend job progress meetings in accordance with requirements set by Owner or Consultant.
- B. Additional Coordination: Contractor shall request additional job construction coordination meetings it deems to be necessary to ensure coordination of their responsibilities with other parties.
- C. Progress Inspection: Consultant may perform periodic progress inspections. At Consultant's request, Contractor shall make Project Manager and/or Lead Technician available.
- D. Test Plan: Ten (10) business days prior to the proposed Contractor test date, Contractor shall provide a test plan defining the tests required.
 1. The test plan shall be approved by Consultant prior to any testing.

1.16 CONSTRUCTION PROGRESS SUBMITTALS

- A. Completion: Contractor shall complete and submit via email all construction progress documentation in PDF format as requested by Owner and Consultant.
- B. Contractor shall provide to Consultant the following construction progress submittals in addition to specific requirements identified in subsequent sections.
 - 1. Weekly Report: Weekly written report to be submitted to Consultant through appropriate project channels in PDF format outlining progress from previous week, plans for progress in the current week, and any coordination issues that may require Consultant or Owner attention.
 - 2. Test Plan: Shall ensure the system meets Owner operational and performance specifications and include the following:
 - a. Identification of the capabilities and functions to be tested.
 - b. Detailed instructions for the setup and execution of each test.
 - c. Procedures for evaluation and documentation of the results.
- C. Failure to Complete: Failure to complete requested construction progress documentation may result in the withholding of payment by Owner.

1.17 CLOSEOUT PROCEDURES

- A. Notification: Contractor shall provide written notification to Consultant and Owner when Contractor is satisfied that the work has reached Substantial Completion and is ready for inspection.
- B. Pre-Inspection Submittals: Contractor shall submit an electronic copy of all closeout submittals to Consultant in accordance with the requirements found in these documents no less than ten (10) business days prior to the scheduled Final Inspection.
 - 1. Test Results
 - 2. As-built drawings (full-size sheets)
 - 3. Operation and Maintenance Manuals
 - 4. End User Software
 - 5. Photos that demonstrate complete system installation.
- C. Punch List: Work or materials found to be incomplete, of unsatisfactory quality, failing to meet the specifications in these documents, and/or unacceptable to Consultant or Owner shall be documented by Consultant and provided to Contractor to rectify at no additional cost. Contractor shall provide written notification to Consultant and Owner when all punch list items have been completed.
- D. Final Inspection: At Consultant's request, Contractor shall make Project Manager and/or Lead Technician available.
- E. Re-Inspection: If more than one (1) re-inspection is necessary, the costs of the additional travel, time, and expenses of Owner and Consultant may be deducted by Owner from the contract amount due to the Contractor.
- F. Punch List Approval: Once all punch list items are complete, the Contractor shall return an initialed punch list to the Consultant and Owner for verification. Punch list shall be considered complete only after having been signed by Owner and Consultant.

- G. Closeout Submittals: Upon approval of closeout submittals and prior to final acceptance, Contractor shall provide three (3) electronic copies to Owner and Consultant in format(s) noted below.
1. Record Drawings – AutoCAD 2010 editable .dwg format AND PDF.
 2. Operation and Maintenance Manuals – CD OR DVD.
 3. End User Software – CD OR DVD.
 4. Documentation of testing and system certification.
- H. Closeout Submittal Format and Distribution: Upon approval of closeout submittals and prior to final acceptance, Contractor shall provide a total of three (3) bound hard copies and one (1) digital copy with labeled dividers of all record drawings (full-size sheets) and operation and maintenance manuals, three (3) copies to Owner and one (1) digital copy to Consultant. Title on front and spine of binder shall be "Operation and Maintenance Manual – [Project Name]". The following additional items shall be identified on the binder cover:
1. Client Name
 2. Contractor Name and Contact Information
 3. Consultant Name and Contact Information
 4. Date
- I. All documentation prepared by the Contractor, including hard copy and electronic forms, shall become the property of the Owner.
- J. Payment Authorization: Final payment will be authorized only after all closeout procedures and requirements have been followed and fulfilled by Contractor and approved in writing by Owner and Consultant, including punch list(s) and/or re-inspection(s) and delivery of closeout deliverables.

1.18 CLOSEOUT SUBMITTALS

- A. Closeout submittals are intended to document the details of the final installation that substantially conforms to the construction documents and functions as intended to meet the Owner's needs.
- B. Contractor shall provide to Consultant the following closeout submittals for approval in addition to specific requirements identified in subsequent sections.
1. As-built drawings: As-built drawings are prepared by the Contractor. They show, in red ink, on-site changes to the Consultant-approved pre-construction submittal documents. As-built drawings shall be submitted to Consultant for approval prior to submitting record drawings and include:
 - a. Changes made by Addenda, Change Orders, Requests for Information (RFIs), Architect's Supplemental Instruction (ASIs), or Requests for Proposal (RFPs) in addition to any other changes to the original documents.
 - b. Actual device locations, conduit routing, wiring and relationships as they were constructed.
 - c. Nomenclature showing as-built wire designations and colors.
 - d. Room numbers coinciding with Owner space planning numbering.

2. Record drawings: Record drawings are the final drawings prepared by the Contractor and incorporate all as-built drawing changes previously approved by Consultant. Record drawings should be electronically produced without any handwritten, red ink, or clouded changes.
3. Operation and Maintenance Manuals: Notwithstanding requirements specified elsewhere, submit one (1) copy of each of the following per binder:
 - a. A final Bill of Materials for each system.
 - b. A Microsoft Excel (.xlsx format) spreadsheet for each device that resides on the network provide the following:
 - i. IP Address
 - ii. MAC Address
 - iii. Serial Number
 - iv. Manufacturer
 - v. Model Number
 - vi. Device Username
 - vii. Device Password
 - viii. Telecom Closet or Rack Location
 - ix. Patch Panel Port Number
 - x. Switch Port Number
 - xi. Any other relevant information as requested by Owner
 - c. Manufacturers Instruction Manuals: Specification sheets, operation manuals and service sheets published by the manufacturers of the components, devices and equipment provided.
 - d. Information for testing, repair, troubleshooting, assembly, disassembly, and recommended maintenance intervals.
 - e. Replacement parts list with current prices. Include list of recommended spare parts, tools, and instruments for testing and maintenance purpose.
 - f. Performance, Test, and Adjustment Data: Comprehensive documentation of performance verification according to parameters specified herein.
 - g. Warranties: Provide an executed copy of the Warranty Agreement and copies of all manufacturers' Warranty Registration papers as described herein.
 - h. Sufficient information, (detailed schematics of subsystems, assemblies, and subassemblies to component level) clearly presented, shall be included to determine compliance with drawings and specifications.
 - i. Any other items defined herein.
4. Local Reference Diagrams: Within each equipment rack, enclosure, or cabinet, the Contractor shall place a functional diagram of the system(s) in a clear plastic sleeve secured to the equipment rack, cabinet, or enclosure.
5. Intellectual Property: Provide all required items and written release as described herein.

6. Training Program: Proposed training materials and program outline.
7. Spare Parts and Remote Controls: Contractor shall submit record of Owner sign-off of turnover of spare parts and remote controls.

1.19 PROJECT MANAGEMENT

- A. Project Manager: Contractor shall appoint a Project Manager who will be the main point of contact for Owner and Consultant regarding the project.
- B. Responsibility: Project Manager is responsible for the following:
 1. Successfully completing the contract in a timely manner.
 2. Overseeing work and performance of all employees and Subcontractors who have been hired by Contractor, and ensuring compliance with specification.
 3. Completing and submitting required documentation.
 4. Attending project coordination meetings as required by Owner, Consultant, and Contractor. Contractor is responsible for taking minutes of these meetings and distributing copies to all participants in a timely manner.
 5. Coordinating with Owner, Consultant, Architect, General Contractor, and other Contractors involved in the project to ensure smooth flow of work and on-time project completion.
 6. Providing a written weekly progress update to the Owner and Consultant in a PDF format emailed to the project team.
 7. Reporting all unexpected conditions and problems that may result in delay or expense to Owner and Consultant immediately upon discovery.
- C. Change of Project Manager: If Contractor seeks to change Project Manager during the course of the Project, such change is subject to prior written approval from Owner.
- D. The Owner reserves the right to request a change of project manager at any time for any reason.

1.20 EXAMINATION OF EXISTING CONDITIONS

- A. Examination: Contractor shall examine the facility and construction documents to the extent necessary to plan for efficient installation strategies prior to the delivery of materials to the site or the commencement of work. Other documents (Architectural Drawings, hardware schedules...) may be made available upon request. Failure to adequately complete the examination shall not result in change order requests.
- B. Acceptance of Conditions: Commencement of work by Contractor shall indicate acceptance of existing conditions, unless a written notice of exceptions has been provided to Owner prior to commencement.
- C. Observation: If Contractor observes—during preliminary examinations or subsequent work—existing violations of fire stopping, electrical wiring, grounding, or other safety- or code-related issues, Contractor shall report these to Owner in a timely manner.
- D. Pre-Existing Damage: If Contractor observes damage to finished surfaces before they begin installation in any area, Contractor shall document by taking digital photos of the damaged area(s) and immediately notify Construction Manager and Consultant via email with attached photos.

- E. Damage during Installation: Any damage caused by, or reasonably believed by the Construction Manager to be caused by the Contractor shall result in back-charges for said damages. Repairs shall match preexisting color and finish of walls, floors, and ceilings. Any Contractor damaged ceiling tiles, floor, and carpet shall be replaced to match color, size, style, and texture.

1.21 CONTRACT MODIFICATION PROCEDURES

- A. Changes: Changes to the contract may be initiated by Owner, Consultant or Contractor.
- B. Request for Information (RFI): If a change originates with Contractor, the Contractor shall submit an RFI for Consultant review. If it is deemed a change is necessary, the Consultant shall issue a PR to address the change.
- C. Proposal Request (PR): If a change originates with Owner or Consultant, Consultant shall issue a Proposal Request to Contractor.
- D. Change Proposal (CP): If a change originates with Contractor, or if Contractor receives a Proposal Request from Consultant, Contractor shall submit a Change Proposal to Consultant to review.
 - 1. References: A Change Proposal shall reference the work to be performed, and shall include the cost change to the Project (if any) and the time change to the scheduled completion (if any).
 - 2. Additional Information: Consultant may request additional information to be supplied with the Change Proposal for consideration.
 - 3. Acceptance: Owner reserves the right to accept or reject Change Proposals.
- E. Change Order: A Change Order is a modification of the contract.
 - 1. If a Change Proposal is approved, Owner will issue a Change Order that references PR and/or CP. Change Order is not valid until it has been signed by Owner.
 - 2. Work performed or equipment supplied outside of contract without a valid Change Order is done at Contractor's own risk.

1.22 PRODUCT STORAGE AND HANDLING REQUIREMENTS

- A. Storage: Contractor shall provide secure material storage. If Contractor chooses to store cabling or equipment at project site, that Contractor shall receive written approval from GC or Owner to identify acceptable location. All equipment provided by the Contractor remains the responsibility of that Contractor until Owner has beneficial use of the equipment.
- B. Protection: Contractor shall take all necessary precautions to protect materials from the following:
 - 1. Theft
 - 2. Vandalism/Tampering
 - 3. Dents
 - 4. Scratches
 - 5. Dust
 - 6. Temperature
 - 7. Weather

8. Cutting
 9. Paint
 10. Other hazardous conditions
- C. Replacement: Contractor shall replace any damaged or lost material as required by Owner or Consultant.
- D. Installed Materials: Installed materials remain the responsibility of the Contractor until Acceptance. Contractor shall take necessary precautions to ensure the safety and security of installed materials.

1.23 INTERFERENCE WITH THE FACILITY

- A. Transportation and storage of materials at the facility, work involving the facility, and other matters affecting the habitual use by the Owner of the Owner's buildings, shall be conducted to minimize interference, and at times and in a manner acceptable to the Owner.

1.24 ON-SITE CONDUCT

- A. Conduct: Any demonstration of rudeness, use of profanity, or lack of respect by Contractor Personnel to a building tenant will be cause for immediate removal from the premises, and such Personnel will not be allowed to return. Contractor and Contractor's Personnel are to remain in project area.
- B. Vandalism: Graffiti or vandalism will not be tolerated. Any Contractor/Personnel caught in the act shall be immediately removed from the premises and will not be allowed to return.
- C. Hazardous Conditions: No one shall be allowed to endanger the building, its premises, or its occupants in any manner whatsoever. In the event that a situation occurs which threatens the building or its occupants in any manner, Contractor, Contractor Personnel, Subcontractor, etc. shall take immediate steps to correct the hazardous condition. In the event that Contractor's Personnel fail to correct hazardous condition, Owner reserves the right to immediately take steps to correct the situation at Contractor's expense.

1.25 SAFEGUARDS AND PROTECTION

- A. Barriers: Provide and maintain suitable barriers, guards, fences and signs where necessary to accommodate the safety of others relative to and/or for the protection of this work.
- B. Regulations: Comply with OSHA, Federal, State, Local, and Owner regulations and standards pursuant to this work.
- C. Protection: Protect all materials and equipment to prevent the entry or adhesion of any and all foreign material. If necessary, cover equipment with temporary protective material suitable for this purpose.
- D. Finishing: Check, clean and remove defects, scratches, fingerprints and smudges if necessary from all equipment and devices immediately prior to Acceptance of the Installation.
- E. Damage: Replace all damaged or defective material or work at no additional cost prior to Final Acceptance.
- F. Documentation: Provide written description of accidents by workers, staff, and general public of any incident occurring on the project. Report incident in writing to Owner's representative immediately and to the Project Manager for follow up.

1.26 OWNER-FURNISHED PRODUCTS

- A. Delivery: Owner is responsible for delivery of Owner-furnished products to the project site, unless otherwise specified in this document.
- B. Placement: Contractor is responsible for locating, inspecting, and moving Owner-furnished products to their final installation position.
- C. Inspection: Contractor shall report any damage, discrepancies in quantity, type, or function to Owner and Consultant immediately upon discovery.
- D. Warranty: Contractor assumes no responsibility for any material warranty for Owner-furnished products. Contractor shall be responsible for integrating, cabling, and installing Owner-furnished products under the same warranty conditions as other products furnished by Contractor.

1.27 QUALITY ASSURANCE

- A. Assurance: It is the intent of these specifications to describe and provide for a complete, professional, and reliable installation.
- B. Qualifications: Contractor employees who are engaged in installation shall be properly trained in the tasks they are expected to perform.
- C. Acceptability: Owner shall determine the acceptability of work.
- D. Regulatory Requirements: Contractor shall comply with code requirements that apply to the work being performed.
- E. Certifications: Where manufacturer certifications are required for warranty or for authorized resale, installation personnel shall have received such certification prior to the start of installation of those manufacturers' materials.

1.28 QUALITY CONTROL

- A. Installation: During installation period, when connections are made to the Owner's existing infrastructure, Contractor shall use care to ensure that such connections will not have a negative impact which could reduce or hamper existing systems.

1.29 OWNER'S RIGHT TO USE EQUIPMENT

- A. The Owner reserves the right to use equipment, material and services provided as part of this work prior to Acceptance of the Work, without incurring additional charges and without commencement of the Warranty period.

1.30 INTELLECTUAL PROPERTY OWNERSHIP

- A. All intellectual property shall remain in escrow for an unlimited period of time. All supporting documentation including but not limited to: software, firmware, programming, uncompiled source code, graphic files, diagrams, written and electronic files, including all latest versions of the documentation and software necessary to edit and adapt the system(s), shall be provided to the Owner on a CD or DVD for all spaces and all systems. The integrator and/or programmer shall also maintain a current live copy incorporating all system modifications to be provided at the Owner's request and for system restoration upon a failure.
- B. A written release shall be given by the Contractor and all other required parties for all programming and configuration done by the Contractor and/or Subcontractors. This release will acknowledge the Owner's

ownership and right to modify the intellectual property directly, or to have the intellectual property modified by any party of the Owner's choosing.

PART 2 - PRODUCTS

2.1 BASIC EQUIPMENT AND MATERIALS REQUIREMENTS

- A. Standards: Equipment and materials used to accomplish the goals of this project shall meet standards for good engineering practice as defined within this document.
- B. Quality: Products specified in these documents are intended to establish a baseline or operational, functional, and performance-based standards that all proposed products shall meet or exceed by functionality and quality.

2.2 FACTORY-ASSEMBLED PRODUCTS

- A. Manufacturer: Reference to specific equipment manufacturers does not imply that all products produced by that manufacturer meet the specification requirements.
- B. Age of Equipment: Equipment shall be new and unused with full manufacturer's warranties. Contractor shall supplement such warranties as required by the specification. Contractor shall immediately notify Consultant of any product that will be or is expected to be discontinued by the end of the project for resolution.
- C. No Modification: Where a product is available from a factory/manufacturer to meet the needs as outlined, that product shall be used without modification to ensure the full factory warranty is maintained.
- D. Like Materials: Like materials used shall be of the same manufacturer, model, and quality unless otherwise specified.
- E. Software/Firmware: No software or firmware is to be used unless specifically authorized by Owner or its appointed representative.

2.3 RACKS, CABINETS, HARDWARE

- A. Equipment Racks and Cabinets: Provide racks and cabinets as specified herein and/or described in accompanying documents, appendices, or drawings. Verify that any existing racks and/or cabinets provided by others are complete, bringing any discrepancies to the attention of Owner and Consultant prior to beginning the installation.
- B. Shelves and Mounts: Contractor shall supply necessary mounting hardware to install rack-mounted equipment. Mounting hardware shall be a product of the manufacturer of the equipment to be mounted, or manufacturer of the rack system, or approved by either for use with their product. Provide supporting channels, shelves, rack mounts, and/or rack ears as recommended by equipment manufacturers.
- C. Screws and Washers: Contractor shall provide screw head types appropriate to the level of security required for the equipment and racking. Screws shall include polyethylene or nylon washer.
 - 1. Public Access Areas: Star post or square post security screws shall be used for hardware and equipment mounted in equipment racks and consoles in areas that are accessible to the public.
 - 2. Restricted Access Areas: Philips head screws may be used where a secure room entrance or locked rack/console door prevents public access.

2.4 POWER DEVICES

- A. Power Strips: Unless otherwise specified, power strips shall be UL listed, surface mounted, and rated for 20 amp continuous electronic loads. Outlets shall be 125 volt, 20 amp, three-wire, grounded, and NEMA 5-20R compliant. Cords shall be 12/3 SJT with molded plug.
- B. Power Distribution Panels: Unless otherwise specified, power distribution panels shall be UL listed, rack mounted, rated for 20 amp continuous electronic loads, with switch and pilot light. Up to eight outlets shall be mounted to the back, each rated 125 volt, 20 amp, three-wire, grounded, and NEMA 5-20R compliant. Switch and pilot shall be mounted to the front. Cords shall be 12/3 SJT with molded plug.
- C. Contractor shall provide acceptable power distribution units as required in order to provide sufficient outlet connectivity for Contractor-furnished and Owner-furnished equipment indicated on drawings and equipment schedules, plus up to 15% additional capacity for future growth. This may be in addition to any power distribution equipment indicated on equipment schedules.

2.5 CABLE AND CONNECTORS

- A. Cable: Cable shall be selected and applied in a manner defined by signal type, consistent with best industry practices. Highest quality products shall be used with attention given to transmission characteristics, termination methods, resistive and complex impedance at operating frequencies, and insulating material characteristics. Where required by the NEC, substitutions of air handling plenum cable shall exactly match the normally applied product and shall meet the standards of UL Standard #900 and the NEC Articles 800 and 820.
- B. Connectors: Highest quality products shall be used with attention given to transmission characteristics, termination methods, resistive and complex impedance at operating frequencies, and insulating material characteristics. Strain reliefs and cable clamps shall be sized for the connector and the cable.
- C. Color: Cable and connector color shall be coordinated with Consultant to maintain consistency with cable and connector color schemes used by other trades.

2.6 CABLE MANAGEMENT

- A. Plastic Cable Ties: Single use white nylon plastic cable ties, appropriate screw fittings, or mounting clips may be used for AC power cable management within racks and enclosures. Plastic/nylon cable ties shall not be used for signal and DC cables.
- B. Velcro Cable Ties: Velcro straps shall be used for all signal and DC cables. Velcro straps shall be black, with no logo or decoration, except as authorized by Consultant.

2.7 ANCILLARY HARDWARE

- A. General: Contractor shall provide ancillary and required accessory items necessary to provide a complete and fully functional system to Owner.
- B. Interpretation: Exclusion of or limitation in the language used in the drawings or specifications shall not be interpreted as meaning that ancillary or accessory items of work or equipment necessary to complete or make the installed system fully functional can be omitted.

2.8 GROUNDING HARDWARE

- A. Refer to Section 27 05 26 for specific Grounding and Bonding requirements.

- B. Provide data/telecommunication grounding systems indicated in the project drawings and specifications. Products shall include, but are not limited to, cables/wires, connectors, terminals, compression lugs, grounding rods/electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE, ANSI/TIA and established industry standards for applications indicated.

2.9 FIRE STOPPING MATERIALS

- A. All penetrations of walls shall be approved by the General Contractor before any penetrations are made. Should the Contractor find it necessary to penetrate any walls extending to the slab, it will be the responsibility of that Contractor to provide satisfactory sleeving and fire caulking both inside and outside of that sleeving. If existing sleeving is to be utilized, it will be the responsibility of the Contractor to fire caulk inside the sleeving.
- B. The Contractor is responsible for adhering to the following standards:
 - 1. Conduit penetrations through fire-rated or smoke walls: Completely seal around the conduit penetration with Hilti FS 601 fire-rated sealant or equivalent by Tremco, 3M, or equal.
 - 2. Conduit sleeves through fire-rated or smoke wall: Completely seal around the conduit penetration with Hilti FS 601 fire-rated sealant or equivalent by Tremco, 3M, or equal. Completely seal inner opening of the conduit sleeve with fire wool packing and Hilti FS 611A intumescent firestop sealant.
 - 3. Cable bundles through fire-rated or smoke walls (without sleeves): Completely seal openings with Hilti FS 611A intumescent firestop sealant or equivalent by Tremco, 3M, or equal.
 - 4. Cable tray penetrations through fire-rated or smoke walls: Completely seal openings with Hilti FS 635 (trowelable type), or equivalent by Tremco, 3M, or equal.
- C. A submitted response to this specification assumes that all firestopping will be provided as specified. The firestop manufacturer's specifications and instructions shall be submitted with the final documentation.

2.10 COMPATIBILITY OF RELATED EQUIPMENT

- A. Existing Equipment: Equipment and systems specified in these documents shall be assumed to be compatible with the systems already installed at Owner site(s) and as identified in this document as related to this project.
- B. Installed Equipment: Specified equipment and systems shall be compatible with all other equipment and systems as offered by Contractor, thus placing the responsibility on Contractor to ensure proper interaction.

2.11 LICENSES

- A. Any and all licenses required for system functionality shall be provided.

2.12 SPARE PARTS

- A. Suggested List: Contractor is requested to submit a list of suggested spare parts with an offered price, allowing Owner to select appropriate parts.
- B. Means of Obtainment: Contractor shall state where spare parts can be obtained after the installation.

2.13 MAINTENANCE MANUALS

- A. Contractor shall produce a maintenance manual showing interconnection of equipment and any special procedures necessary for proper operation and maintenance of the systems.

PART 3 - EXECUTION

3.1 GENERAL

- A. Contractor shall provide, furnish, deliver, transport, erect, install, connect and configure all of the material and equipment described herein or depicted on any bid package document or drawing, as required for a turnkey solution.

3.2 COORDINATION

- A. General: Contractor shall cooperate with other Contractors for proper provisioning, anchorage, placement, and execution of all work. Interference between the work of various Contractors shall be resolved before installation. In the event of conflict on space requirements or location of devices, refer the matter to Owner and Consultant for decision.
- B. Related Work: References to the following related work do not limit or release Contractor from the responsibility of coordination with other trades or from having the necessary knowledge of other non-referenced work.
 - 1. Work by General Contractor.
 - 2. Work by other Technology Contractors.
 - 3. Work by Electrical Contractor, including electrical rough-ins and surface-mounted raceway.
- C. Delays: Contractor shall coordinate with all other trades to avoid causing delays in the installation schedule.
- D. AC Power: Contractor shall coordinate with General Contractor its requirements for proper AC power to service all equipment installed by Contractor.
- E. Low Voltage Sleeving: Contractor shall provide openings through walls as necessary, with sleeving and fire-stopping materials installed in a professional manner to meet local and national codes.
- F. Grounding and Bonding: Contractor shall coordinate with General Contractor its requirements for proper grounding and bonding to their equipment.

3.3 BASIC EXECUTION REQUIREMENTS

- A. General: Contractor is responsible for following industry standards of good practice for telecommunications and networking equipment.
- B. Aesthetic Factors: With the installation of equipment and cables, consideration shall be given not only to operational efficiency but also to overall aesthetic factors. Contractor shall redo, at no cost to Owner, any work deemed by Owner to appear sloppy, hastily done, or unprofessional. Owner shall make final decision over whether work shall be redone.
- C. Manufacturers' Recommendations: Manufactured items, materials, and equipment shall be applied, installed, connected, erected, used, and adjusted as recommended by the manufacturers or as indicated in their published literature unless otherwise noted herein.

- D. Protection of Work Area: Work shall be properly protected during construction; including shielding soft or fragile materials, protecting against dust and dirt, protecting and supporting cable ends off of the floor and from other traffic, protecting floor box lids, and temporarily plugging open conduits during construction. Upon completion, installation shall be thoroughly cleaned and all tools, equipment, obstructions, or debris present as a result of work shall be removed from the premises.
- E. Protection of Cable and Equipment: Contractor shall make appropriate preparations to protect all cabling and equipment from foreign material. Foreign material is defined as any substance or material that would void the manufacturer's performance warranty, impact ratings (UL, Plenum, etc.), or cover up markings needed for inspection. Foreign material includes, but is not limited to, paint overspray (intentional or not), fire-stopping material, drywall compound, or any other chemical, liquid, or compound that could come in contact with cables, cable jackets, cable termination points, or other equipment.
 - 1. Cleaning of cables or equipment with harsh chemicals from a failure to comply with Protection of Cable and Equipment clause is unacceptable. Contractor shall replace any affected cable, cable components, or equipment in their entirety at Contractor's sole cost.
- F. Waste Materials: Contractor shall keep work area neat, orderly, and free from accumulation of waste materials. Remove trash and debris from the building and job site as required to maintain a clean work environment at all times. Rubbish shall be moved to a common trash point or receptacle on the job site as determined and directed by General Contractor or Owner.
- G. Dumpsters: No construction debris shall be placed in building's dumpsters. Contractor shall provide a dumpster for construction waste and debris at own expense. Said dumpster shall be emptied on a regular schedule. Location of dumpster shall be arranged through Building Management. Appropriate measures shall be taken to protect asphalt or other ground surfaces.
- H. Ceiling Grid: Contractor shall not hang cable supports from ceiling grid wire.
- I. Roof Deck: Contractor shall not shoot into the roof deck for mounting cable hangers.
- J. Mounting: Equipment and enclosures shall be mounted plumb and square in relation to the structure.
- K. Raised Floor: All cabling installed below the raised floor shall be placed in the provided cable trays with appropriate means to hold cable in place. If no cable tray exists, Contractor shall provide J-hooks to hold cables in place. Sleeves shall be utilized for cable egress.
- L. Motorized Furniture: Care shall be taken to properly dress all cables placed within motorized furniture and provide sufficient cable length and strain relief to allow motorized elements to operate within their full range of travel.
- M. Flexible Furniture: Care shall be taken to properly dress all cables placed within flexible or re-configurable furniture to provide sufficient cable length and strain relief to allow full range of travel for flexible furniture configurations.

3.4 PREPARATION

- A. Existing Equipment: Prior to any installation, the Contractor shall prepare the site by removing any remaining debris, leveling equipment racks (where appropriate), and verifying information and systems stated to be in-place are ready for use.
- B. Equipment for Installation: Prior to installation, Contractor shall ensure that required major equipment has been secured and is ready for installation.

3.5 CLEANING

- A. Tool Clean-up: Contractor is not permitted to use restrooms for tool clean-up. A slop-sink may be provided in janitorial closet on each floor for cleaning of tools and equipment and as a source of water. Janitorial closet or maintenance area or shop shall be kept clean at all times. Contractor or Contractor's Personnel found using restrooms for clean-up or other similar purposes shall be subject to removal from building.
- B. Daily: At the end of each work period or day, Contractor shall remove excess packing, drilling remnants, and other non-equipment related parts, materials, or debris to ensure a clean, safe, and professional working environment.
- C. Carpet: Contractor shall ensure that no damage to carpeting occurs as a result of their work. Contractor shall cover carpets in areas of work to prevent wire and other debris from entering the carpet.

3.6 FIRE STOPPING

- A. Contractor is responsible for applying fire-stopping material in and around all openings that it creates or are created for it, whether or not specifically indicated in specifications or project drawings, where code requires the use of fire stopping material.
- B. Contractor shall ensure that all fire-stopping materials meet appropriate codes and are installed in a neat and workman like manner.

3.7 WATERPROOFING

- A. Contractor is responsible for creating a waterproof seal in and around any openings to the outside environment that are created by Contractor or for systems being installed.
- B. Contractor shall ensure that all waterproof materials meet appropriate codes and are applied according to good engineering practice.

3.8 RACKS, CABINETS, AND HARDWARE

- A. Racks and Cabinets: Contractor shall assemble and install racks and cabinets.
- B. Installation Hardware: Install hardware in a secure manner. Screws shall be tightened to a torque just sufficient to secure equipment without deforming washers beyond their original diameter.
- C. Considerations: Rack mount equipment shall be secured as recommended by the manufacturer with consideration to airflow, power, and in/out connections.
- D. Cross Connections: Where cross connections are required between equipment, interconnections shall be installed using cable management devices to secure cables in a neat and workmanlike manner, applying best industry practices.

3.9 INSTALLATION REQUIREMENTS

- A. Cable pulling shall be done in accordance with cable manufacturer's recommendations and ANSI/IEEE C2 standards. Recommended pulling tensions and pulling bending radius shall not be exceeded. Any cable bent or kinked to radius less than recommended dimension shall not be installed.
- B. All cable shall be pulled by hand unless installation conditions require mechanical assistance. Where mechanical assistance is used, care shall be taken to ensure that the maximum tensile load for the cable as defined by the manufacturer is not exceeded. This may be in the form of continuous monitoring of pulling tension, use of a "break-away", or other approved method.

- C. Qualified personnel utilizing state-of-the-art equipment and techniques shall complete all installation work. During pulling operation, an adequate number of workers shall be present to allow cable observation at all points of pathway entry and exit.
- D. All cable shall be free of tension at both ends.
- E. PLENUM rated cable shall be used in areas used for air handling or where required by code.
- F. Contractor shall replace any cables that have been damaged or abraded during installation.
- G. Pulling lubricant may be used to ease pulling tensions. Lubricant shall be of a type that is non-injurious to the cable jacket and other materials used and will not harden or become adhesive with age.
- H. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit or surface mount raceway.

3.10 CABLE

- A. Cable treatment: Cable shall be stored and handled to assure that it is not stretched, kinked, crushed, or abraded in any way. Bend radiuses shall meet manufacturer specifications and/or recommendations. Cable shall not be installed in ambient temperatures or moisture conditions above or below the rating of the manufacturer.
- B. Splicing
 - 1. Voice, data, and other twisted pair cables: No splices shall be installed in any voice, data or twisted pair cables.
 - 2. Technology systems: No splices shall be installed in any cable less than five hundred (500) feet in length.
 - 3. Digital multimedia/video cables: No splices are allowed in any digital multimedia/video cable.
 - 4. Overhead paging systems: Cable splices for constant voltage overhead paging system shall occur only at speaker, amplifier or volume control knob locations.
- C. Lengths
 - 1. Variations: Where cables are to be of the same length, variations in the length shall be less than plus or minus ½ inch. Lengths of cables are based on the length of the unterminated signal conductors.
 - 2. Labeling: Cables, regardless of length, shall be marked with a labeling scheme approved by Consultant.
 - 3. Service Loops: A surplus of cable, located at or near the point of termination to facilitate potential future changes, shall be provided where appropriate. Cables shall have a minimum cable slack of 10ft (3m) at the telecommunication room(s) and 3.28ft (1m) at each telecommunications outlet in the suspended ceiling unless noted otherwise. Service loops shall be stored in an extended loop or in a figure-eight configuration, not in bundled loops.
- D. Grouping
 - 1. Cables shall be separated into like groups according to signal or power levels.
 - 2. Power Cable Group: Power cables shall be secured to one side of the rack separate from any low-energy signal cable groups. Separation shall be a minimum of 4" in all directions.

3. Signal Cable Group: Signal cables shall be grouped according to signal type and secured to one side of the rack separate from any power cable groups. Separation shall be a minimum of 4" in all directions.
- E. In Equipment Racks
1. Equipment rack wiring and cabling shall be neatly dressed.
 2. Fastening: Rack cabling shall be adequately supported with Velcro wire wraps and horizontal support cable managers fastened to rack frame.
- F. Support for Cables Outside of Equipment Racks
1. External wire and cables shall be supported at least every 5 feet (1.5m) from the structure and as required to maintain less than 12 inches of cable sag between supports without over-tensioning the cables. Contractor shall vary the precise distance between cable supports on long runs to avoid harmonics issues.
 2. Hardware: Cables shall be supported by J-hooks, cable tray, or ladder rack. Hardware shall be secured to building structure using 3/8" threaded rod supports.
 - a. Right Angles: Cables are to run at right angles to the structure, placed above ceiling in halls or corridors.
 - b. Height: Cables shall not run above red iron joist.
- G. Concealment: Contractor shall make every effort to conceal wiring and other apparatus into walls, floors, and ceilings, assuming code and good engineering practice allows and suggests. Cabling systems installed in public areas shall be installed within walls, ceiling, or floors or within surface wiring pathways, as dictated by codes and good engineering practice.
- H. Velcro Straps for Horizontal Cabling: Straps shall be installed snugly without deforming cable insulation. Straps shall be spaced at uneven intervals not to exceed 4 feet.
- I. Cable Ties and Velcro Straps within Equipment Racks and Cabinets: Ties and straps shall be installed snugly, without deforming cable insulation, at uneven intervals not to exceed 8 inches. Cable ties shall only be used for non-signal carrying cables. No sharp burrs shall remain where excess length of the cable tie has been cut.
- J. Obstruction: Contractor shall notify Owner immediately if any obstruction or hazard is discovered in a pathway provided by others.

3.11 CONNECTORS

- A. Preparation: Cables shall be carefully prepared and connectors installed as directed by the manufacturer. Proper stripping devices and crimping tools shall be used.
- B. Terminations: Connectors shall be carefully fitted to mating devices on equipment to avoid damage to mating contacts, inserts, or bodies. Specialized terminations shall be made in a neat and secure manner suited to the service of the wire and as directed by the manufacturer. Contractor shall use manufacturer specified terminations when those specifications exist.
- C. Soldering: A person skilled in that practice shall execute soldered terminations. Any excessive insulation displacement resulting from soldering shall be grounds to require the Contractor to re-terminate the connector.

- D. Adapters: Adapters shall be used only where the identity of the necessary type of connector is unknown at the time of installation, such as for Owner-provided equipment or in anticipation of future equipment upgrades, with Consultant's approval.

3.12 SPARE PARTS AND REMOTE CONTROLS

- A. Keys: Contractor shall turnover all keys, tagged and organized by type on individual key rings, to Owner upon project completion.
- B. Refer to individual sections for spare parts and remote control requirements.

3.13 EQUIPMENT INSTALLATION

- A. General: Contractor shall make system properly operational and physically secure by mounting equipment and related accessories into furniture, consoles, and racks as required. Manufacturer's guidelines for installation shall be followed. Discrepancies in installation procedure or inability to complete a given task due to a shortage of materials or malfunctioning equipment shall be reported to Consultant immediately upon discovery.
- B. Equipment Placement: Contractor shall locate equipment as indicated on drawings and as specified herein. Where such information is not provided, Contractor shall follow industry best practices and locate operable devices at convenient positions; heat generating devices at the top and seldom-accessed equipment below.
 - 1. Unless otherwise specified, end user-operable devices shall be positioned within the range of front wheelchair access per ADA standards.
- C. Equipment Installation: Equipment shall be installed as directed by the manufacturer using equipment manufacturer's desktop mounting frames, equipment tubs, installation hardware, and techniques. Contractor shall be responsible for moving equipment from storage and for providing necessary personnel or devices to carry and lift equipment around obstacles and into operating position.

3.14 FIRMWARE

- A. Firmware shall be latest version supported by software and/or equipment as of Date of Acceptance.

3.15 ROUGH-IN

- A. Scheduling: Contractor shall make every effort to install systems per this specification in a timely manner including rough-in of cabling and other apparatus where appropriate to stay on schedule.
- B. Protection of Environment: Where cabling and/or equipment is installed prior to other trades completing their work in an area, Contractor shall take necessary precautions to cover, wrap, or otherwise protect to reduce possible damage which may result from plastering, painting, cleaning, or other such work completed after installation and before substantial completion of the project.

3.16 CUTTING, DRILLING, PATCHING, AND PAINTING

- A. Coordination: Contractor is responsible for coordinating with the General Contractor and other trades when any cutting or drilling is required for the installation or proper performance of the specified systems.
- B. Restoration: Contractor is responsible for returning all surfaces (including walls, floors, and ceilings) to their previous condition after any cutting including painting.

- C. Painting: Contractor is responsible to paint all new work including exposed pathway to match the conditions.

3.17 LABELING

- A. General: Rack-mounted equipment and hardware shall be labeled as required herein. Connectors, jacks, receptacles, outlets, cables, cable terminations, terminal blocks, rack mounted equipment, active slots of card frame systems, etc. shall be clearly, logically, and permanently labeled in a manner acceptable to Consultant.
- B. Approval: Proposed wording and/or numbering schemes for labeling shall be provided to Consultant for review and written approval prior to procurement or installation.
- C. Labels used shall be permanent and secure. Provide labeling as follows unless otherwise noted in a specific section:
 - 1. Like Size: All labels, including engraved labels, shall be sized to match other labels used for same purpose.
 - 2. Equipment Racks: For enclosed racks containing equipment, provide labels on each equipment rack rear door or console rear panel reading "No user serviceable parts. Refer service to qualified technician."
 - 3. Installer and Consultant Identification: Position at the front top center section of each equipment rack a label that states the names of system Installer and Consultant.
 - 4. Custom Panels: Custom panel nomenclature shall be engraved, etched, or screened. Markings are to be designed to ensure consistency and clarity within and without of system. Verify markings and placements by submitting label sample layouts to Consultant for approval prior to procurement.
 - 5. Documentation: Labeling information shall appear on the as-built drawings.

3.18 FIRE-STOPPING

- A. If Contractor removes anything from an opening in a fire-rated wall, Contractor shall restore the fire-rating condition of the wall to the same condition as before Contractor started its work. Depending on the size of the opening, this may involve sheetrock patching, in addition to use of other appropriate fire-stopping materials

3.19 ADDITIONAL ENGINEERING SERVICES

- A. General: Contractor is responsible for securing necessary engineering services where needed to meet the needs of the installation.
- B. Change Orders: Only when Contractor can show that additional engineering services are needed as a result of changes to the scope of the services being requested in the contract documents will Owner entertain a Change Order Request for these services.

3.20 TESTING

- A. Procedure: Contractor shall develop a rigorous testing procedure to ensure full functionality and durability of installed systems under heavy-use conditions.
- B. Supplies: Contractor shall supply testing equipment needed to verify compliance with specifications found in these documents.

- C. Schedule: Contractor shall complete required testing prior to the substantial completion inspection by Owner and Consultant.
- D. Data: Test data shall be properly documented and recorded so that it is available for final inspection.
- E. Quality Control: Testing may be repeated during the inspection process at the request of Owner or Consultant.
- F. Prior to energizing or testing the system, Contractor shall ensure the following:
 - 1. Installation: Products are installed in a proper and safe manner per the manufacturer's instructions.
 - 2. Cleanliness: Products are neat, clean, and unmarred and parts securely attached. Dust, debris, solder, splatter, etc. is removed.
 - 3. Cables and Connections: Cable is dressed, routed, and labeled; connections are consistent with regard to polarity.
 - 4. Grounding: Electronic devices are properly grounded.
 - 5. AC Power: Each AC power receptacle is tested with a circuit checker for proper hot, neutral, and ground connections prior to connecting equipment.

3.21 GROUNDING

- A. Refer to Section 27 05 26 for specific Grounding and Bonding installation requirements.

3.22 TRAINING PROGRAM

- A. Contractor shall provide training in the manner delineated below in addition to specific requirements identified in subsequent sections.
- B. Contractor shall provide audio-video recording of each training session to Owner.
- C. Prior to scheduling or delivering End User training, Contractor shall confirm that:
 - 1. Closeout submittals have been accepted by Owner and Consultant.
 - 2. Final closeout inspection has been completed and punch list items rectified.
 - 3. Training schedule dates have been coordinated with and approved by Owner and Consultant.
- D. Training shall include:
 - 1. Approved handouts.
 - 2. Practical and comprehensive operation of systems.
 - 3. Basic system troubleshooting techniques.
 - 4. Basic system maintenance.
- E. Training Blocks
 - 1. Training time is defined as those hours specifically set aside for the sole purpose of training end users. Credited time will not be given for any time spent providing instructions to the Owner's staff for a system not completed or that has not passed final acceptance by the Owner and Consultant, or training performed outside of the approved training program.

2. This training will be divided into training session "Blocks" as coordinated with the Owner.
 3. The first training session block shall consist of training intended for the common system operators. Such training, at a minimum, shall include the day to day use of the system.
 4. The second training session block shall consist of training administrators of the day to day administration of the system. Such training, at a minimum, shall include use of the administration control functions of the systems, user setup, and filtering and pulling reports.
 5. The third training session block shall consist of training administrators on system troubleshooting, maintenance, and updates. Such training, at a minimum, shall include using the system tools to diagnose issues, diagnosing common physical equipment issues, performing simple maintenance, and performing system updates.
 6. The fourth training session block shall consist of a training session structured for high-level users, for example staff trainers who will provide instruction to other users and will include advance system configuration and operational knowledge needed to maintain and manage all specified technology systems. The Contractor may elect to engage the Manufacturer(s) in certifying the high-level end users in the systems at no cost to the Owner.
- F. The Contractor shall issue a certificate of training completion to the trainees upon completion of their training. Such certificates must be signed by both the trainer and trainee(s) for the Contractor to receive training credit.

3.23 WARRANTY AND MAINTENANCE PROGRAM

- A. Contractor shall provide a warranty conforming to the stipulations below in addition to specific requirements identified in subsequent sections.
- B. As part of the base proposal cost, the Contractor shall include a 1-year turnkey warranty period with full support costs.
- C. The Warranty period shall begin after all punch list items have been rectified. The Contractor shall receive a letter of completion from the Consultant and Owner indicating project completion and starting the warranty period.
- D. The warranty and support work included in this contract shall cover the following materials, software, and services, without additional cost to the Owner:
 1. Inspections, preventative maintenance, and testing of equipment and components. The Contractor shall schedule a 10-month on-site preventative system review 10-months into each year of warranty and support including system inspections, preventive maintenance, software upgrades/patches, and testing of equipment and components.
 2. Regular Service, Emergency Service, and Normal Service.
 3. Labor, travel, equipment, materials, and transportation cost for all services covered by this warranty.
- E. Response Time: Contractor shall respond to calls for warranty services in a timely manner as delineated below.
 1. The Owner reserves the right to make the final determination of emergency or normal service calls and the right to coordinate the best times for service of any system failure.

2. Emergency service calls are defined as failures which prohibit the use of a typical system function(s) and pose a life safety concern, or such failures which cause a major impact to the Owner's daily operations.
 - a. The Contractor shall provide remote service diagnosing the impact within two (2) hours after notification by the Owner.
 - b. If remote service does not correct the reported issue, the Contractor shall provide on-site service correcting the impact within four (4) hours after notification by the Owner.
 3. Normal service calls are defined as failures which prohibit the use of typical system function(s) but which do not inhibit critical system usage, do not pose life safety concerns, and do not create a major impact to Owner's daily operations.
 - a. The Contractor shall provide remote service correcting the impact within twenty-four (24) hours after notification by the Owner.
 - b. If remote service does not correct the reported issue, the Contractor shall provide on-site service correcting the impact within forty-eight (48) hours after notification by the Owner.
 4. The Contractor shall supply Service Request forms and or proper contact procedure to the Owner with instructions for proper notification of the Contractor for warranty service. By following said instructions, the Owner shall constitute proper notification for any needed warranty service
- F. Repair Time: Contractor shall locally stock critical parts in sufficient quantities such that emergency repair or replacement shall be guaranteed within twelve (12) hours. Temporary replacements within this time period shall be acceptable, provided temporary replacements do not compromise system functionality and provided permanent replacement is achieved within ninety-six (96) hours. Contractor may contact the Owner for use of Owner supplied spare parts where delay of system repair will have negative impact on system performance.
- G. Transmittal: A copy of this Warranty shall be delivered to and signed for by the Owner's representative whose primary responsibility is the operation and care of these systems. A copy of the signed Warranty document shall be delivered for review as part of the Final Submittals.
- H. Registration: Contractor shall register Warranty papers for all equipment and software in the name of the Owner and furnish reproductions of all equipment Warranty papers to the Owner with the Final Submittals.
- I. Subcontracting: Warranty service work may not be subcontracted except with specific permission and approval by the Owner.
 1. Service/Warranty Procedures: Contractor shall submit a warranty service plan containing all contact information and Owner service call directions for Owner review with project close-out submittals.
- J. Resolution of Conflicts:
 1. The Owner retains the right to resolve unsatisfactory warranty service performance at any time by declaring the work unsatisfactory and stating specific areas of dissatisfaction in writing.
 2. If the Contractor or his approved Subcontractor does not resolve such stated areas of dissatisfaction within ninety-six (96) hours, the Owner may appoint an alternative service agency or person to fulfill the terms of the Warranty at the expense of the Contractor. This action may be taken repeatedly until the Owner is satisfied that Warranty service performance is satisfactory. Satisfactory resolution of a malfunction shall be considered adequate when the device, equipment, system or component which is chronically malfunctioning is brought into compliance

with the standards of performance as contained herein and published by the manufacturers of the equipment installed.

End of Section

DIVISION 27

Technology

95% Construction Documents

PART 1 - GENERAL

1.1 SCOPE

- A. Refer to Section 27 00 00 for additional project scope information.
- B. This section describes the products and execution requirements related to furnishing and installing Category 5e/6/6a Cabling and Termination Components and related subsystems as part of a Structured Cabling System.
- C. Backbone system fiber optic cabling and horizontal cabling is covered under this document.
- D. Others will provide the network electronics for the LAN within the Telecom Rooms (TRs) and will be responsible for connecting the new cabling infrastructure to the LAN. The Contractor, however, shall supply the patch cords. The Contractor shall be available on site during the crossover to assist with any cabling issues that may occur during the connection.
- E. The Electrical Contractor shall install conduits for new technology outlet locations unless otherwise noted.
- F. The Telecommunication Contractor shall provide and install all sleeves through the wall penetrations as required whether or not specifically marked on Project Drawings, unless otherwise noted.
- G. All cables and related terminations support, and grounding hardware shall be furnished, installed, wired, tested, labeled, and documented by the Contractor, as detailed in the following section(s).
- H. All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association, the Electrical Code in the State of Texas, and present manufacturing standards.
- I. All materials shall be listed by UL and shall bear the UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.

1.2 RELATED WORK

- A. Section 27 00 00 – General Technology Requirements
- B. Section 27 05 23 – Pathways for Technology Systems
- C. Section 27 05 26 – Grounding and Bonding for Technology Systems
- D. Section 27 11 00 – Communications Equipment Rooms
- E. Section 27 13 00 – Communications Backbone Cabling
- F. Section 27 15 00 – Communications Horizontal Cabling
- G. Section 27 16 00 – Communications Connecting Cords
- H. Section 27 18 00 – Communications Labeling and Identification

1.3 DEFINITIONS

- A. Refer to Section 27 00 00 for additional definitions.

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 for additional requirements.
- B. All references relate to the current version adopted by the city/county according to the authority having jurisdiction (AHJ). If the city/county has not adopted a version the latest version shall be utilized.
- C. ASTM B633: Specification for Electrodeposited Coatings of Zinc on Iron and Steel
- D. ASTM A653: Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process
- E. ASTM A123: Specification for Zinc (Hot Galvanized) Coatings on Iron and Steel
- F. ASTM A510: Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
- G. ANSI/TIA 569-C: Telecommunications Pathways and Spaces
- H. ANSI/TIA 568-C.0, 1, 2, 3, 4: Commercial Building Telecommunications Standard
- I. ANSI/TIA-598-C-2005 – Optical Fiber Cable Color Coding
- J. ANSI/TIA 606-B: Administration Standard for Telecommunications Infrastructure
- K. ANSI/TIA 942-A: Telecommunications Infrastructure Standard for Data Centers
- L. ANSI/TIA 607-B: Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises
- M. IEEE: National Electrical Safety Code® (NESC®)
standards.ieee.org/about/nesc

1.5 QUALIFICATIONS

- A. Refer to Section 27 00 00 for additional requirements.
- B. Premises Distribution System: Written certification that the premises distribution system complies with the EIA ANSI/TIA/EIA-568-C.0,1, 2, 3, EIA ANSI/TIA/EIA-569-B, and ANSI/TIA/EIA-606-A.
- C. Materials and Equipment: Where materials or equipment are specified to conform, be constructed, or be tested to meet specific requirements, Contractor shall supply, upon request by Consultant or Owner, certification that the items provided conforms to such requirements. Certification by a nationally recognized testing laboratory that a representative sample has been tested to meet the requirements, or a published catalog specification statement to the effect that the item meets the referenced standard, will be acceptable as evidence that the item conforms. Compliance with these requirements does not relieve the Contractor from compliance with other requirements of the specifications.
- D. Certifications
 - 1. The Contractor shall have an RCDD (Registered Communication Distribution Designer) on staff assigned to manage this Project; documented proof shall accompany the proposal response.
 - 2. All installing personnel shall have completed and be certified in manufacturer training or BICSI (Building Industry Consulting Service International) installation training for UTP infrastructure systems, or the Contractor shall contract with manufacturer for installation of all proposed components. Company Certifications shall accompany the proposal response.
 - 3. The Contractor's technicians shall be certified and trained in the connectivity hardware which is being installed.

4. The Contractor shall submit certification that installers are factory certified to install and test the provided products. No less than half of the crew to be used for the telecommunications installation shall be trained by that manufacturer for the work.

1.6 PRE-CONSTRUCTION SUBMITTALS

- A. Shop Drawings in addition to requirements in Section 27 00 00:
 1. Equipment rack elevation details
 2. Elevations of telecommunication room walls with planned mounted equipment
 3. Outlet faceplate details for all outlet configurations, sizes, and cable types
 4. Overhead telecommunication room enlargements, providing dimensions of room and clearance for maintenance and operation

1.7 CONSTRUCTION PROGRESS SUBMITTALS

- A. Refer to Section 27 00 00 for requirements.

1.8 CLOSEOUT SUBMITTALS

- A. Refer to Section 27 00 00 for requirements.
 1. Data cable test results
 2. CD containing:
 - a. As-built drawings (CAD format)
 - b. As-built drawings (PDF format)
 - c. Detailed test results in original tester format (e.g. Fluke Linkware)
 - d. Detailed cable test results in PDF format
 3. Warranty certification from connectivity manufacturer

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Contractor shall be responsible for all materials until completion of Project.
- B. Cable shall be stored according to manufacturer's recommendations at minimum. In addition, cable shall be stored in a location protected from vandalism and weather.
- C. If cable is stored outside, it shall be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 40 degrees Fahrenheit, the cable shall be moved to a heated (minimum 50 degrees Fahrenheit) location. If necessary, cable shall be stored off site at the Contractor's expense.
- D. If the Contractor wishes to have a trailer on site for storage of materials, arrangements shall be made with the Owner.
- E. Commercial off-the-shelf manuals shall be furnished for operation, installation, configuration, and maintenance for all products provided as a part of the premises distribution system. Specification sheets for all cable, connectors, and other equipment shall be provided.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.2 FIRE STOPPING MATERIALS

- A. Refer to Section 27 00 00 for additional requirements.

PART 3 - EXECUTION

3.1 TESTING

- A. Refer to Section 27 00 00 for additional requirements.

3.2 TRAINING

- A. Refer to Section 27 00 00 for additional requirements.

3.3 WARRANTY

- A. Refer to Section 27 00 00 for additional requirements.
- B. The Contractor shall provide to the Owner a manufacturer's 15-year minimum warranty certificate for all materials, equipment, etc. Upon successful completion of the installation and subsequent inspection, the Owner shall receive the numbered certificate from the manufacturing connectivity hardware (patch panels, jacks, patch cords 110 blocks, etc.) company registering the installation. This warranty shall include all labor, materials, and travel time.
- C. The warranty shall ensure against product defects and guarantee that all approved cabling components exceed the specifications of TIA/EIA-568-C and ISO/IEC IS 11801 for cabling links/channels, and that the installation will exceed the loss and bandwidth requirements of TIA/EIA 568-C ISO/IEC IS 11801 for fiber links/channels for a fifteen (15) year period. The warranty shall apply to all passive structured cabling system components.
- D. The warranty shall cover the failure of the wiring system to support the application that it was designed to support, as well as additional application(s) introduced in the future by recognized standards or user forums that use the TIA/EIA 568-C or ISO/IEC IS 11801 component and link/channel specifications for cabling. Such warranty shall apply for a minimum of a fifteen (15) year period.
- E. The warranty shall cover the replacement or repair of defective product(s) and labor for the replacement or repair of such defective products(s), labeling of the new components, and testing of the circuit(s) at no cost to the Owner.

3.4 EXAMINATION

- A. Verification of Conditions: Contractor shall examine areas and conditions under which work is to be performed and identify conditions detrimental to proper and timely completion.
- B. Contractor shall verify that cable lengths comply with published standards.
- C. Contractor shall notify Owner of any proposed installation which is expected to exceed maximum lengths prior to installation of cable.

- D. Contactor shall consult with Owner regarding alternative routing or location of cable.
- E. Contractor shall not proceed until unsatisfactory conditions have been corrected.

3.5 SPARE PARTS

- A. Suggested List: Contractor is requested to submit a list of suggested spare parts with an offered price, allowing Owner to select appropriate parts.
- B. Means of Obtainment: Contractor shall state where spare parts can be obtained after the installation.

3.6 INSTALLATION REQUIREMENTS

- A. Refer to Section 27 00 00 for additional requirements.

3.7 COOPERATION

- A. The Contractor shall cooperate with other trades and General Contractor's personnel in locating work in a proper manner.
- B. Should it be necessary to raise, lower, or move longitudinally any part of the work to better fit the general installation, such work shall be done at no extra cost to the Owner, provided such decision is reached prior to actual installation. The Contractor shall check location of electrical outlets with respect to other installations before installing.

3.8 TESTING AND ACCEPTANCE

- A. The Contractor shall perform acceptance tests as indicated below for each subsystem (backbone, station, etc.) as it is completed.
- B. The Contractor shall supply all equipment and personnel necessary to conduct the acceptance tests. Prior to testing, the Contractor shall provide a summary of the proposed test plan for each cable type, including equipment to use, setup, test frequencies or wavelengths, results format, etc. The Consultant will approve the method of testing.
- C. The Contractor shall visually inspect all cabling and termination points to ensure that they are complete and conform to the wiring pattern defined herein. The Contractor shall provide the Consultant with a written certification that this inspection has been made.
- D. The Contractor shall conduct acceptance testing according to a schedule coordinated with the Consultant. Representatives of the Owner may be in attendance to witness the test procedures. The Contractor shall provide a minimum of one (1) week advance notice to the Consultant and Owner to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.
- E. Tests related to connected equipment of others shall be done only with the permission and presence of Contractor involved. The Contractor shall ascertain that testing only as required to prove the wiring connections are correct.
- F. The Contractor shall provide Consultant with test results and descriptions of the testing methodology, including the date of the tests, the equipment used, and the procedures followed. At the request of the Consultant, the Contractor shall provide copies of the original test results.
- G. All cabling shall be 100% fault free unless noted otherwise. If any cable is found to be outside the specification defined herein, that cable and the associated termination(s) shall be replaced at the Contractor's expense. The applicable tests shall then be repeated.

- H. The Consultant or Owner may request that a 10% random field re-test be conducted on the cable system to verify documented findings.
 - 1. If requested, the Contractor shall test up to 10% of cable links at no cost to the Owner.
 - 2. Tests shall be a repeat of those defined above and under Testing and Acceptance. If findings contradict the documentation submitted by the Contractor, additional testing shall be performed to the extent determined necessary by the Consultant, including a 100% re-test. This re-test shall be at no additional cost to the Owner.

3.9 FIRE STOPPING

- A. Contractor shall seal any openings created for cable pass-through between floors or through fire rated walls. Sealing material and application of this material shall be accomplished in such a manner that is acceptable to the local fire and building authorities having jurisdiction over this work.
- B. Creation of such openings as are necessary for cable passage between locations as shown on the Drawings shall be the responsibility of the Contractor. Any openings created by or for the Contractor and left unused shall also be sealed as part of this work.

End of Section

PART 1 - GENERAL

1.1 SCOPE

- A. Refer to Section 27 00 00 for additional project scope information.

1.2 RELATED WORK

- A. Section 27 00 00 – General Technology Requirements
- B. Section 27 05 00 – Communications General Requirements
- C. Section 27 05 26 – Grounding and Bonding for Technology Systems
- D. Section 27 11 00 – Communications Equipment Rooms
- E. Section 27 13 00 – Communications Backbone Cabling
- F. Section 27 15 00 – Communications Horizontal Cabling
- G. Section 27 16 00 – Communications Connecting Cords
- H. Section 27 18 00 – Communications Labeling and Identification

1.3 DEFINITIONS

- A. Refer to Section 27 00 00 for additional definitions.

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 for additional requirements.

1.5 QUALIFICATIONS

- A. Refer to Section 27 00 00 for additional requirements.

1.6 PRE-CONSTRUCTION SUBMITTALS

- A. Refer to Section 27 00 00 for additional requirements.

1.7 CONSTRUCTION PROGRESS SUBMITTALS

- A. Refer to Section 27 00 00 for additional requirements.

1.8 CLOSEOUT SUBMITTALS

- A. Refer to Section 27 00 00 for additional requirements.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

- B. Cable Drop Out/Waterfall
 - 1. Where cables bundles transition from tray to tray or tray to conduit or sleeve of varying elevations the Contractor shall provide and install a radius control device. This device shall be a waterfall or drop out device and shall be properly sized to accommodate cable bundle plus 20% future growth.
- C. T-sections of tray shall be made using T-section fittings.
- D. Straight section splices shall be made using splice plates.
- E. Wire basket runway supports shall be of the trapeze hanger type.
- F. Trapeze hangers shall be supported by 3/8 inch diameter rods.
- G. Tray shall have an electro zinc finish or a flat Black finish wherever finished installation will be visible to end users.
- H. Accessories (connectors, splice plates...) shall be painted to match tray finish.
- I. Contractor shall refer to project drawings for cable tray sizing.
- J. Manufacturer: Cable trays and accessories shall be of one of the following manufacturers
 - 1. Chatsworth
 - a. 12" universal cable runway: 10250-712
 - b. 12" cable radius drop, cross member: 12100-712
 - c. 12" cable radius drop, stringer: 12101-712
 - d.

2.2 CABLE PATHWAY SLEEVES

- A. The Contractor shall only provide when re-enterable sleeves are not possible.
- B. The Contractor shall provide all necessary wall penetration for cable pathways whether or not specifically shown on Project Drawings.
- C. All wall penetrations shall have a metallic sleeve(s) as required to maintain a maximum 40% fill ration.
- D. All sleeves shall be properly firestopped by this Contractor.
- E. Contractor shall provide all core holes, pathways and sleeves (minimum 1.25" c).
- F. Contractor shall install non-metallic threadless insulating bushings on end of all conduits.
- G. Conduit Core Holes and Sleeves thru Floor: For all floor penetrations, Contractor shall provide IMC conduits with threaded steel couplings set flush with finish floor. Extend 6" above finish floor with IMC before any termination.

2.3 RE-ENTERABLE FIRESTOP SLEEVES

- A. Manufacturer:
 - 1. STI EZ Path

2. Hilti Speedsleeve
3. Or approved equal

2.4 METAL CONDUITS AND FITTINGS

- A. All intra-building cabling shall be routed between it's network room or pull box and end device in EMT. Cabling shall have no more than two (2) 90 degree bends before an intermediate pull box is added.
- B. General Requirements for Metal Conduits and Fittings:
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Comply with TIA-569-B.
 3. GRC: Comply with ANSI C80.1 and UL 6.
 4. EMT: Comply with ANSI C80.3 and UL 797.
 5. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - a. Fittings for EMT:
 - i. Material: Steel
 - ii. Type: Setscrew
 6. Expansion Fittings: Steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.

2.5 OUTLET BOXES

- A. General Requirements for Outlet Boxes
 1. Comply with TIA-569-B.
- B. Metallic outlet boxes and device covers shall be galvanized steel not less than 1/16" thick.
- C. The dimensions of the metallic outlet box shall be 2"x4", 4"x4" and 6"x4" with a minimum depth of 2.5". See drawings for details.
- D. Metallic outlet boxes shall be equipped with single device cover (or two-device cover where needed).
- E. Where installed in plaster, gypsum board, etc., covers shall be raised to compensate the thickness of the wall.
- F. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- G. Where metallic outlet boxes are to be empty for future use, blank covers shall be used.
- H. Gangable boxes are not allowed.

2.6 PAINTING

- A. The Contractor is responsible for painting all exposed pathway, boxes, fittings, etc. The paint shall match the surrounding conditions and may change mid-run.

PART 3 - EXECUTION

3.1 TESTING

- A. Refer to Section 27 00 00 for additional requirements.

3.2 TRAINING

- A. Refer to Section 27 00 00 for additional requirements.

3.3 WARRANTY

- A. Refer to Section 27 00 00 for additional requirements.

3.4 WIRE BASKET TRAY RUNWAY

- A. Basket tray shall be installed in accordance with recognized industry practices, to ensure that the cable tray equipment complies with requirements of NEC, applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.
- B. Coordinate installation of wire basket runway with other electrical work as necessary to properly interface installation of wire basket runway with other work.
- C. Provide sufficient space encompassing wire basket runways to permit access for installing and maintaining cables.
- D. Test wire basket runways to ensure electrical continuity of bonding and grounding connections and to demonstrate compliance with specified maximum grounding resistance.

3.5 CABLE HOOK SYSTEM

- A. J-hooks fabricated to contain data/voice and video cables may be used to support 25 or fewer cables in each hook. J-hooks are to be fastened to building steel with beam clamps, suspended from ceiling slab with threaded rod, or anchored to the wall. All J-hooks shall be hung straight and level. No other installation technique will be authorized unless pre-approved.
- B. Three tiered double-sided J-hook configurations shall contain a maximum of 25 cables per hook or 150 cables. Smaller configurations may be used as bundles decrease in size, maintaining no more than 25 cables per hook.
- C. Bundles surpassing 150 cables shall be supported by hangers, fabricated of 3/8" threaded rod and 24" Unistrut. Hangers shall also be installed where the installation of a three-tiered J-hook system is not appropriate for the ceiling space, or where blocked by other trades' work.
- D. Cable bundles consisting of fewer than 10 cables may be supported by single J hooks.
- E. All cable support in the main cable path shall be installed every four feet. Small cable bundles (under 25) not in the main path may be supported every five feet.
- F. A sag shall be maintained between supports of 6", to reduce cable strain. Velcro is an appropriate method of securing cables, when properly used and not over tightened.
- G. Proper cable support is extremely important to the Owner, and care shall be taken by the Contractor to provide and install the appropriate supports. Supports found to be inadequate will be replaced.
- H. Cable bundles including voice/data cabling shall not have plastic cable ties.

- I. All cable trunks shall have radius controlled cable waterfalls where trunk drops from conduit, sleeve or tray from horizontal path to vertical path.

3.6 SURFACE RACEWAY SYSTEM

- A. In areas where surface raceway will be used as a cable path, no exposed cable shall be permitted.
- B. With the agreement of the Consultant and Owner, if a telecommunications outlet is required in an area where the walls cannot be fished, the station cable serving these outlets shall be covered with raceway. No exposed cable shall be permitted within offices, laboratories, and conference rooms, or like facilities. Contractor shall attempt to fish hollow walls, use existing conduit, or exhaust all other options to conceal cabling prior to installing surface raceway.
- C. The raceway shall originate from a surface mounted box located off the floor and be attached to the wall and terminate above the ceiling. The outlet box height shall match existing electrical receptacle height. Raceway for a wall-mounted location shall originate from a surface mounted box with the top of the box located 48" off the floor.
- D. Minimum bend radius shall be adhered to for UTP and fiber optic cable.
- E. Where raceway is to be installed on painted, smooth, finished surfaces, the Contractor shall clean surface prior to installing raceway.
- F. Where non-metallic raceway is to be installed on non-smooth surfaces such as wallpaper, unpainted brick, concrete, etc., the Contractor shall use flat-head screws in addition to the adhesive backing to fasten channel to surfaces.
- G. Where Contractor is required to install metallic raceway, the raceway base shall be installed using flat-head screws and following all manufacturer's recommendations.
- H. Where new outlet locations are indicated on Project Drawings as having existing Wiremold™ type raceway, the Contractor shall remove existing raceway from wall and install new specified raceway to cover any damage or markings caused from removing existing raceway product.
- I. All surface raceway shall be mounted level and plumb. Where the Owner considers raceway channels to be installed unsatisfactorily, the Contractor shall remove and replace necessary channels at no additional cost to the Owner.
- J. Suitable insulating bushings and inserts shall be used at connections to outlets and corner fittings. Dropped ceiling end fittings shall be utilized where raceway channel connects to dropped accessible ceiling tile. In rooms with drywall ceilings, open ceilings, or non-accessible ceilings, the Contractor shall extend raceway to the nearest location, hallway, or corridor that has accessible ceiling cavity. All cables shall be concealed.

3.7 PATHWAY APPLICATIONS

- A. Indoors: Apply pathway products as specified below unless otherwise indicated:
 1. Exposed, Not Subject to Physical Damage: EMT
 2. Concealed in Ceilings and Interior Walls and Partitions: EMT
- B. Minimum Pathway Size for Data: 1-inch trade size. Cable fill shall not exceed a 40% fill ratio.
- C. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. EMT: Use setscrew, steel fittings. Comply with NEMA FB 2.10.

3.8 INSTALLATION

- A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- C. Complete pathway installation before starting conductor installation.
- D. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- E. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- G. Support conduit within 12 inches of enclosures to which attached.
- H. All conduit penetrations shall comply with all applicable fire codes. All conduit penetrations in fire-rated walls or floors shall be sealed and fire proofed to at least the rating of the penetration area.
- I. Conduits shall be routed in the most direct route, with the fewest number of bends.
- J. There shall be no continuous conduit sections longer than 100 feet. For runs that total more than 100 feet, insert junction or pull boxes (or gutters if appropriate) so that no continuous run between pull boxes is greater than 100 feet.
- K. There shall be no more than two 90-degree bends (180 degrees total) between conduit pull boxes.
- L. Changes in direction shall be accomplished with sweeping bends observing minimum bend radius requirements above. Do not use pull boxes for direction changes unless specifically designated otherwise in the Drawings.
- M. Stub-ups to Above Recessed Ceilings:
 1. Use EMT for pathways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- O. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

- Q. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- R. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb. tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.

3.9 OUTLET BOXES

- A. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- B. Exact locations of the outlet boxes shall be coordinated with the electrical contractor and other trades.
- C. The approximate locations of the outlets are indicated on the drawings. The exact locations shall be determined at the building. The right is reserved to change without additional cost, the exact location of any outlet, a maximum of 10' before it is permanently installed.
- D. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a rain tight connection between box and cover plate or supported equipment and box.
- E. Horizontally separate boxes by a minimum of 12" mounted on opposite sides of walls so they are not in the same vertical channel.
- F. Outlet boxes installed back to back in fire-rated walls shall be separated horizontally by a minimum of 24".
- G. Install all outlet boxes in finished areas flush with the wall. Maintain ¼" or less space between outlet box front and finished wall surface.
- H. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- I. Outlet boxes shall be firmly anchored in place and shall not depend on the cover plate to hold it secure to the wall.
- J. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- K. Any surface boxes shall have rounded corners and edges. Surface boxes must be approved by Owner prior to installation.

3.10 RISER CONDUITS

- A. Conduits entering equipment rooms shall be reamed or bushed and terminated not more than 4" from a wall and within 12" of room corners.
- B. Conduits entering equipment rooms from below floor shall be terminated not more than 4" above finished floor.
- C. Conduits shall not be less than 4" trade size and be equipped with a measured pull line at 12" increments rated at a minimum 1200 pound test.
- D. Provide restorable fire stops inside and around conduits as recommended by UL1479 or ASTM E814 for all conduits penetrating fire-rated construction.

- E. Provide an insulating press fit bushing on all telecommunications riser conduits. Bushings must be rated to be used in an environmental air handling space (Plenum).

3.11 SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.12 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

End of Section

PART 1 - GENERAL

1.1 SCOPE

- A. Refer to Section 27 00 00 for additional project scope information.

1.2 RELATED WORK

- A. Section 27 00 00 – General Technology Requirements
- B. Section 27 05 00 – Communications General Requirements
- C. Section 27 05 23 – Pathways for Technology Systems
- D. Section 27 11 00 – Communications Equipment Rooms
- E. Section 27 13 00 – Communications Backbone Cabling
- F. Section 27 15 00 – Communications Horizontal Cabling
- G. Section 27 16 00 – Communications Connecting Cords
- H. Section 27 18 00 – Communications Labeling and Identification

1.3 DEFINITIONS

- A. Refer to Section 27 00 00 for additional definitions.

1.4 REFERENCE STANDARDS AND CODES

- A. IEEE C2 - National Electrical Safety Code
- B. IEEE Std. 837-2002, or latest version – Standard for Qualifying Permanent Connections Used in Substation Grounding
- C. ANSI/TIA-607 - Commercial Building Grounding and Bonding Requirements for Telecommunications
- D. NFPA 70E - Standard for Electrical Safety in the Workplace
- E. ANSI/NECA/BICSI-607 - Telecommunications Bonding and Grounding Planning and Installation methods for Commercial Buildings
- F. UL 467 - Standard for Grounding and Bonding Equipment
- G. Refer to Section 27 00 00 for additional requirements.

1.5 QUALIFICATIONS

- A. Refer to Section 27 00 00 for additional requirements.

1.6 PRE-CONSTRUCTION SUBMITTALS

- A. Refer to Section 27 00 00 for additional requirements.

1.7 CONSTRUCTION PROGRESS SUBMITTALS

- A. Refer to Section 27 00 00 for additional requirements.

1.8 CLOSEOUT SUBMITTALS

- A. Refer to Section 27 00 00 for additional requirements.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.2 GROUNDING AND BONDING CABLE

- A. The grounding and bonding cable shall be stranded copper conductors.
- B. The grounding and bonding cables shall have a green jacket color and riser or plenum rated as required.
- C. Feeder and Branch Circuit Equipment Ground: Size as shown on drawings, specifications, or as required by NFPA 70, whichever is larger. Differentiate between normal ground and isolated ground when both are used within the same facility.

2.3 GROUNDING AND BONDING BUSBARS

- A. Telecommunications Main Grounding Busbar (TMGB)
 - 1. Factory-drilled solid copper with holes to accommodate lugs. Field manufactured busbars are not acceptable.
 - 2. 0.25" thick x 4" wide
 - 3. Sized for current applications and future growth, no less than 18"
 - 4. Insulated from its support
 - 5. Shall be an electro-tin plated busbar
 - 6. Maintain a minimum of 2" of clearance from wall
 - 7. UL listed and BICSI certified
- B. Telecommunications Grounding Busbar (TGB)
 - 1. Factory-drilled solid copper with holes to accommodate lugs. Field manufactured busbars are not acceptable.
 - 2. 0.25" thick x 4" wide
 - 3. Sized for current applications and future growth, no less than 12"
 - 4. Insulated from its support
 - 5. Shall be an electro-tin plated busbar
 - 6. Maintain a minimum of 2" of clearance from wall

7. UL listed and BICSI certified
- C. Horizontal Equipment Rack or Cabinet Busbar
 1. Mounts to standard 19" Rack or Frame
 2. Capacity: 6 Double hole lugs
 3. Shall be an electro-tin plated busbar
 4. UL listed and BICSI certified
- D. Vertical Equipment Rack or Cabinet Busbar
 1. Mounts to vertical rail or inside of cabinet in 19" or 23" equipment rack or frame.
 2. Capacity: 9 Double hole lugs
 3. Shall be an electro-tin plated busbar
 4. UL listed and BICSI certified

2.4 MECHANICAL CONNECTORS

- A. Mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers, and lock washers shall be made of Silicon Bronze and supplied as a part of the connector body and shall be of the two bolt type.
- B. Split bolt connector types are not allowed.
- C. Connectors shall meet or exceed UL 467.

2.5 COMPRESSION LUGS

- A. Shall be UL & CSA listed
- B. Shall meet or exceed the performance requirements of IEEE 837, latest revision
- C. Compression type
- D. Shall be manufactured from pure wrought copper. Conductivity of this material shall be no less than 99% by IACS standards.
- E. Shall be electro-tin plated
- F. Lugs shall be 2-hole. Single hole lugs are not allowed
- G. Long barrel that will allow a minimum of two crimps with standard industry colors
- H. Each connector shall be filled with an oxide-inhibiting compound
- I. Crimped with a compression, tool and die system, according to manufacturer's recommendation

2.6 TAPS

- A. Connections to the Conductor shall be made with irreversible compression connectors
- B. Shall be UL & CSA listed

- C. Requires a minimum of (2) crimps for C Tap or H Tap, 1 crimp for I-Beam and busbar Tap
- D. Crimp according to manufacturer's recommendation

PART 3 - EXECUTION

3.1 GENERAL

- A. Install products in accordance with manufacturer's recommendations.
- B. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- C. Mechanical connections shall be accessible for inspection and maintenance.
- D. No insulation shall be installed over mechanical ground connections.
- E. Ground connection surfaces shall be cleaned and all connections shall be made so that disconnection or removal is impossible.

3.2 RESISTANCE MEASUREMENT

- A. Measure ground resistance from system neutral connection at service entrance to convenient ground reference point using suitable ground testing equipment. Resistance shall not exceed 2 ohms.

3.3 TELECOMMUNICATIONS BONDING BACKBONE (TBB)

- A. The intended function of a TBB is to reduce or equalize potential differences between telecommunications systems. While the TBB will carry some current under ac power ground fault conditions, it is not intended to provide the only ground fault return path.
- B. The TBB shall:
 - 1. Be connected to the TMGB & TGB.
 - 2. Be a continuous copper conductor that shall be sized no less than 6 AWG to a maximum of 3/0 AWG. The TBB shall be sized in accordance to the following table:

Linear Length – ft.	Size (AWG)
Less than 13	6
14 - 20	4
21 - 26	3
27 - 33	2
34 - 41	1
42 - 52	1/0
53 - 66	2/0
Greater than 67'	3/0

- 3. The TBB conductors shall be installed and protected from physical and mechanical damage.
- 4. The TBB conductors should be installed without splices.

- a. Where splices are necessary, the number of splices should be kept to a minimum and they shall be accessible and located within telecommunications spaces or j-box labeled as a telecommunications bonding backbone splice.
 - b. Joined segments of a TBB shall be connected using exothermic welding, irreversible compression-type connectors or equal.
- C. A metallic cable shield shall not be used as a TBB.

3.4 GROUNDING EQUALIZER (GE)

- A. The GE shall be a continuous copper conductor that shall be sized no less than 6 AWG to a maximum of 3/0 AWG. The GE shall match the size of the TBB.
- B. The GE shall connect to the telecommunications grounding busbar(s) in the same-floor telecommunications rooms on the first, top, and every third floor in a building greater than 4 floors.
- C. A metallic cable shield shall not be used as a GE.

3.5 TELECOMMUNICATIONS EQUIPMENT BONDING CONDUCTOR (TEBC)

- A. Connects the TMGB/TGB to equipment racks and cabinets.
- B. Shall be a continuous copper conductor that shall be sized per the length of cable.
- C. Shall be separated from ferrous materials by 2" or be bonded to the ferrous metal.
- D. May be routed within cable trays or suspended 2" under or off the side of the cable tray or ladder rack.
- E. Shall be supported every 3ft.
- F. 8" minimum bend radius.
- G. May come cross other cable groups at a 90 degree angle only.
- H. A metallic cable shield shall not be used as a TEBC.

3.6 RACK OR CABINET BONDING CONDUCTOR

- A. A bonding conductor shall be used to connect the equipment racks and cabinets directly to the TMGB, TGB or underfloor ground mesh network.
- B. All metallic enclosures, including remote mounted equipment cabinets and racks for telecommunications, security or audio/visual shall be bonded to the nearest TMGB or TGB using a minimum sized conductor of 6 AWG. Remote bonds shall be labeled on both ends stating the destination of the bond.

3.7 ELECTRICAL DISTRIBUTION PANEL (EDP)

- A. The AC EDP serving the Telecommunications Room shall be bonded to the TMGB or TGB using a minimum of a 6 AWG cable.
- B. A qualified electrician shall make all connections within an AC electrical distribution panel.

3.8 OPTICAL FIBER CONDUCTIVE CABLES

- A. Conductive fiber-optic cables should be bonded and grounded as specified in the NEC.

3.9 CONDUIT AND SLEEVE BONDING

- A. All conduits and sleeves entering a telecommunications room shall be grounded.

3.10 LADDER RACK AND/OR CABLE TRAY

- A. All low voltage cable runway sections shall be bonded together and bonded back to the nearest Telecommunications Room the runway is serving as close TMGB or TGB as practical.
- B. Maintain an 8" minimum bend radius on the TEBC.
- C. Keep a 2" separation from other cables both power and telecommunications.
- D. Remove any paint, oxidation, etc. from the runway surfaces that are being bonded.
- E. Drill two holes as required to accommodate the 2-hole compression lug.
- F. Apply a thin coat of antioxidant around the holes and on the surface where the lug will be in contact.
- G. Attach straps to the runway using stainless steel hardware sized for the lug holes.
- H. Wipe off any excess antioxidant after installation of the lug.

3.11 BUILDING STEEL

- A. Each ground bus bar shall be bonded to building steel.
- B. Remove any paint or fire stopping spray from the building steel.
- C. Provide the appropriate bonding connector to connect to beams, trusses or other types of structure.

3.12 LABELING

- A. Each grounding/bonding cable shall be labeled at the TMGB or TGB.
- B. All taps to the TBB shall be within an enclosure and labeled as to its purpose.
- C. Mechanical connectors shall be clearly marked with the catalog number, conductor size, and manufacturer.
- D. Compression lugs shall be clearly marked with manufacturer, catalog number, conductor size, and required compression tool settings.

3.13 TESTING

- A. Refer to Section 27 00 00 for additional requirements.
- B. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.

3.14 TRAINING

- A. Refer to Section 27 00 00 for additional requirements.

3.15 WARRANTY

- A. Refer to Section 27 00 00 for additional requirements.

End of Section

PART 1 - GENERAL

1.1 SCOPE

- A. Refer to Section 27 00 00 for additional project scope information.
- B. This section describes the products and execution requirements relating to telecommunications cabling, termination components, racks, pathways, telecommunication rooms and related subsystems. Covered systems include the following:
 - 1. Equipment room cable management system and equipment racks
 - 2. Horizontal and backbone cable terminating equipment
 - 3. Telecommunications grounds and related components

1.2 RELATED WORK

- A. Section 27 00 00 – General Technology Requirements
- B. Section 27 05 00 – Communications General Requirements
- C. Section 27 05 23 – Pathways for Technology Systems
- D. Section 27 05 26 – Grounding and Bonding for Technology Systems
- E. Section 27 13 00 – Communications Backbone Cabling
- F. Section 27 15 00 – Communications Horizontal Cabling
- G. Section 27 16 00 – Communications Connecting Cords
- H. Section 27 18 00 – Communications Labeling and Identification

1.3 DEFINITIONS

- A. Refer to Section 27 00 00 for additional definitions.

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 for additional requirements.

1.5 QUALIFICATIONS

- A. Refer to Section 27 00 00 for additional requirements.

1.6 PRE-CONSTRUCTION SUBMITTALS

- A. Refer to Section 27 00 00 for additional requirements.

1.7 CONSTRUCTION PROGRESS SUBMITTALS

- A. Refer to Section 27 00 00 for additional requirements.

1.8 CLOSEOUT SUBMITTALS

- A. Refer to Section 27 00 00 for additional requirements.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.2 CATEGORY 6 PATCH PANELS

- A. Cables shall be terminated at the telecommunication closets on high-density integrated patch panels incorporating Category 6 jacks (non-keyed 8-pin), meeting the specifications for the telecommunications outlet detailed in the section above.
- B. Patch panel configuration shall be 48 ports.
- C. The patch panel shall exceed ANSI/TIA/EIA 568-C.2-1 Category 6 component compliance standard. All pair combinations shall be considered, with the worst-case measurement being the basis for compliance.
- D. The patch panels shall be interoperable and backwards compatible to lower performing cabling systems.
- E. Panels shall incorporate cable support and/or strain relief mechanisms to secure the horizontal cables at the termination block and to ensure that all manufacturers' minimum bend radius specifications are adhered to.
- F. The patch panel shall have color-coded designation strips to identify cable count.
- G. Manufacturers:
 - 1. Panduit
 - a. Mini-Com Flush Mount Modular Patch Panels: CPP48FMWBLY

2.3 FIBER OPTIC PATCH PANELS

- A. The Contractor shall provide a fiber optic patch panel at each location where a fiber optic cable terminates.
- B. All terminated fibers shall be mated to duplex LC couplings mounted on enclosed patch panels. Couplers shall be mounted on a panel that, in turn, snaps into the enclosure. The proposed enclosure shall be designed to accommodate a changing variety of connector types, including SC, ST, Fixed Shroud Duplex (e.g., "FDDI Connector"), Biconic, and FC by changing panels on which connector couplings are mounted.
- C. The patch panel enclosure shall be sized to accommodate the total fiber count to be installed at each location as defined in the specifications and Drawings, including those not terminated (if applicable), PLUS 50% future growth.
- D. The Contractor shall provide all required connector panels and connector couplings (sleeves, bulkheads, etc.) adequate to accommodate the number of fibers to be terminated.
- E. Patch panels shall be designed for easy installation, front removal, and expansion of snap-in adapter panels.

- F. Patch panels shall be enclosed assemblies affording protection to the cable subassemblies and to the terminated ends. The enclosures shall incorporate a hinged or retractable front cover designed to protect the connector couplings and fiber optic jumpers.
- G. The patch panel's enclosure shall provide for strain relief of incoming cables and shall incorporate radius control mechanisms to limit bending of the fiber to the manufacturer's recommended minimums or 1.2", whichever is larger.
- H. Access to the inside of the patch panel enclosure during installation shall be from the front and rear. Panels that require any disassembly of the cabinet to gain entry will not be accepted.
- I. All patch panels shall provide protection to both the "facilities" and "user" side of the coupling. The patch panel enclosure shall be configured to require front access only when patching. The incoming cables (backbone, riser, etc.) shall not be accessible from the patching area of the panel. The enclosure shall provide a physical barrier to access of such cables.
- J. Where singlemode fibers are installed, the fibers contained in these cables may be terminated either by (1) splicing of factory-terminated cable assemblies ("pigtailed") or (2) use of a "fan-out" kit. In the latter approach, individual fibers are to be secured in a protective covering (such as an Aramid reinforced tube, for example) with connectors mated to the resulting assembly. In both instances, the proposed termination hardware shall incorporate a mechanism by which cable and subassemblies are secured to prevent damage. Splicing shall be by the "fusion" method. Individual splice loss shall not exceed 0.2 dB.
- K. Fiber Enclosure
 - 1. Panduit Opticom Rack Mount Fiber Enclosure – # FRMEXX
- L. 9µm Single-Mode Fiber Coupler Panel
 - 1. 9µm Panduit Opticom LC Fiber Adapter Panel – # FAP6WBUDLCZ
- M. Fiber Blank Panel
 - 1. Panduit Opticom Blank Fiber Adapter Panel – Part #. FAPB
- N. 9µm Single-Mode LC Pigtails
 - 1. Panduit Opti-Core OS1/OS2 Single-Mode Fiber Optic Pigtails (LC to Pigtail) – Part # F9B10-NM1Y5. Loose
- O. Tube Fiber Fan-Out Kit
 - 1. Panduit Part # FO12CBCable Management System

2.4 CABLE MANAGEMENT

- A. The cable management system shall be used to provide a neat and efficient means for routing and protecting fiber and copper cables and patch cords on telecommunication racks and enclosures. The system shall be a complete cable management system comprising 2-post floor mount racks and vertical and horizontal cable managers to manage cables on both the front and rear of the rack. The system shall protect network investment by maintaining system performance, controlling cable bend radius, and providing cable strain relief.
 - 1. 2-Post Equipment Racks
 - a. The Contractor shall provide and install 2-post adjustable equipment racks to house cable termination components (e.g., copper data and fiber optic) and network electronics (by

others) as shown on the drawings. Prior to installation, the Contractor shall coordinate exact placement with Owner.

- b. Rack shall be 84" in height and shall be self-supporting.
- c. Rack shall be black.
- d. Channel uprights shall be spaced to accommodate industry standard 19" mounting and have pass-through holes with smooth edges to protect cables.
- e. Rack shall be constructed of aluminum.
- f. Able to support up to 1,500 pounds.
- g. Rack shall be double side drilled and tapped to accept 12-24 screws. Uprights shall also be drilled on back to accept cable brackets, clamps, power strip(s), etc. Hole pattern on rack front shall be per EIA/TIA specifications (5/8"-5/8"-1/2"). Hole pattern on the rear shall be at 3" intervals to accept cable brackets.
- h. Rack shall be supplied with at least 24 spare screws.
- i. Rack shall be supplied with a vertical ground bar and #6 AWG ground lug.
- j. Manufacturers:
 - i. Chatsworth #55053-703
 - ii. Or approved equal.

B. Vertical Cable Management

- 1. At the telecommunication rooms, vertical cable management shall be furnished and installed to adjacent racks to organize cables on front and rear of telecommunication racks.
- 2. Vertical cable managers shall include components that aid in routing, managing, and organizing cable to and from equipment. Panels shall protect network equipment by controlling cable bend radius and providing cable strain relief. Panels shall be a universal design mounting to EIA 19" or 23" racks.
- 3. Vertical cable management system shall feature the following:
 - a. Open cabling section on the rear that provides easy access and routes cable bundles feeding into the back of patch panels and 1 RMU cable guide on the front designed for fanning and managing patch cords.
 - b. Edge-protected pass-through ports designed for easy routing of cable from front channel to back.
 - c. Vertical slots along the center separator to allow securing cable bundles neatly with management straps.
 - d. Door/cover (front only) that is easily opened from the right or left and still easily removed to allow for quick moves, adds, and changes.
 - e. Movable wire retainers to retain the cables during cover removal.
- 4. All Vertical cable management at the end of rack rows shall be 6".
 - a. Double sided vertical cable management system: Panduit PRV6

- b. Vertical cable management door: Panduit PRD6
 - c. 3 finger cable manager: Chatsworth 39112-C14
5. Vertical cable management between racks shall be 10"

2.5 HORIZONTAL CABLE MANAGEMENT

- A. Horizontal cable managers shall include components that aid in routing, managing, and organizing cable to and from equipment. Panels shall protect network equipment by controlling cable bend radius and providing cable strain relief. Panels shall be a universal design mounting to EIA 19" racks and constructed of steel bases with PVC duct attached. The duct fingers shall include retaining tabs to retain the cables in place during cover removal. The covers shall be able to hinge from either side yet still be easily removed to allow for quick moves, adds, and changes.
- B. The cable managers shall be provided with movable wire retainers to retain the cables during cover removal and #12-24 mounting screws. An integral strain relief bracket shall be provided on either end of the duct to allow for easy cover placement.
- C. Double-Sided horizontal cable managers shall be placed above and below each patch panel.
- D. The Contractor shall also supply (1) per 48-port patch panel additional managers for network electronics.
- E. Manufacturers:
 - 1. Panduit NCMH2

2.6 TELECOMMUNICATION GROUND

- A. The Telecommunication Contractor is responsible for providing an appropriate ground for all racks, trays, and telecommunications equipment installed by this Contractor. Refer to the Grounding and Bonding for Technology Systems specification section.

2.7 LADDER RACK

- A. Within each Telecommunications Room, the Contractor shall provide and install ladder rack as shown on the Project Drawings.
- B. Within each Telecommunications Room with a vertical conduit riser the Contractor shall provide and install vertical ladder rack connecting the ground conduit sleeve penetrations with the ceiling conduit sleeve penetrations.
- C. The Contractor shall provide all necessary labor, supervision, materials, equipment, tests, and services to install a complete ladder rack system in the telecommunications room as shown on the Drawings.
- D. Specifications and Drawings are for assistance and guidance, but exact routing, locations, distances, and levels will be governed by actual field conditions.
- E. All splicing assemblies shall be the bolted type using serrated flange locknuts. Hardware shall be either yellow zinc dichromate in accordance with ASTM B633 SC2 or AISI Type 304 stainless steel.
- F. Cable Drop Out/Waterfall
 - 1. Where cables bundles transition from tray and drop into the racks/cabinets, the Contractor shall provide and install a radius control device. This device shall be a waterfall or drop out device and shall be properly sized to accommodate cable bundle plus 20% future growth.

- G. Size ladder rack as indicated on the Contract Documents.
- H. Accessories (connectors, splice plates...) shall be painted to match tray finish.
- I. Manufacturers:
 - 1. Chatsworth
 - a. 12" Universal Cable Runway
 - i. Chatsworth - # 10250-712
 - b. 12" Cable Runway Radius Drop, Cross Member
 - i. Chatsworth - # 12100-712
 - c. 12" Cable Runway Radius Drop, Stringer
 - i. Chatsworth - # 12101-712
 - d. 18" Universal Cable Runway
 - i. Chatsworth - # 10250-718
 - e. 18" Cable Runway Radius Drop, Cross Member
 - i. Chatsworth - # 12100-718
 - f. 18" Cable Runway Radius Drop, Stringer
 - i. Chatsworth - Part No. 12101-718
 - g. Cable Runway Butt-Splice Kit
 - i. Chatsworth - # 11301-701
 - h. Cable Runway Junction-Splice Kit
 - i. Chatsworth - # 11302-701
 - i. Cable Runway Butt-Swivel Splice Kit
 - i. Chatsworth - # 10487-701
 - j. Rack-to-Runway Mounting Kit
 - i. Chatsworth - # 10595-712
 - k. Cable Runway Elevation Kit for Racks
 - i. Chatsworth - # 10506-706
 - l. Cable Runway Elevation Kit for Cabinets
 - i. Chatsworth - # 10506-716
 - m. 12" Triangular Support Bracket, Aluminium
 - i. Chatsworth - # 11312-712
 - n. 12" Wall Angle Support Kit, Cable Runway
 - i. Chatsworth - # 11421-712

- o. 18" Triangular Support Bracket, Aluminium
 - i. Chatsworth - # 11312-718
- p. 18" Wall Angle Support Kit, Cable Runway
 - i. Chatsworth - # 11421-718
- q. 90 Degree Runway-Splice Kit
 - i. Chatsworth - # 11314-701
- r. 45 Degree Runway-Splice Kit
 - i. Chatsworth - # 11313-712
- s. Foot Kit, Cable Runway
 - i. Chatsworth - # 11309-001
- t. Vertical Wall Brackets (pair)
 - i. Chatsworth - # 10608-701
- u. Threaded Ceiling Kit, Cable Runway
 - i. Chatsworth - # 11310-001
- v. Threaded Rod Cover
 - i. Chatsworth - # 11085-001
- w. Protective End Caps for Cable Runway
 - i. Chatsworth - # 10642-001
- x. End Closing Kit, Cable Runway
 - i. Chatsworth - # 11700-712

2.8 PLYWOOD

- A. The Contractor shall provide plywood. Plywood shall be installed on all walls within a telecommunications room and other locations as noted.
- B. Provide void-free, interior grade, fire rated A-C grade plywood, 3/4" by 48" by 96", or as indicated.
- C. When plywood is required to be painted, the paint shall be UL 723 rated white or gray fire retardant. The plywood's rating stamp shall be exposed (not painted over) on each sheet. Plywood shall have fire calk around all edges. Provide label including paint manufacturer, date painted, UL listing and name of Installer
- D. Plywood shall be mounted vertically starting at 22" AFF to 118" AFF and anchored to all studs.

PART 3 - EXECUTION

3.1 TESTING

- A. Refer to Section 27 00 00 for additional requirements.

3.2 TRAINING

- A. Refer to Section 27 00 00 for additional requirements.

3.3 WARRANTY

- A. Refer to Section 27 00 00 for additional requirements.

3.4 EQUIPMENT RACK AND CABINETS

- A. Prior to permanently securing racks or cabinets, the Contractor shall coordinate a walk through with the Owner to determine exact placement of racks.
- B. The Contractor shall bolt the rack to the floor as recommended by the manufacturer. Multiple racks shall be joined and the ground made common on each. Rack shall also be stabilized by extending a brace extending to the wall. Alternately, overhead cable tray over which the cabling accesses the equipment rack(s) shall provide this function.
- C. A space between the rack upright and the wall (~6") shall be planned to allow for cabling in that area. The rear of the rack shall be ~40" from the wall to allow for access by maintenance personnel. In all cases, a minimum of 40" workspace in front of the rack is also required. Locations where these guidelines cannot be followed shall be brought to the attention of the Consultant for resolution prior to installation.
- D. All hardware and equipment is to be mounted at least 18" above floor level. This is to afford easy access and, in the case of the lower limit, prevent damage to the components. Positioning of hardware shall be reviewed and approved by the Consultant and Site Coordinator(s) prior to installation.
- E. Equipment rack shall be equipped with cable management hardware to allow an orderly and secure routing of twisted pair cabling to the data patch panels. At minimum, one such horizontal jumper management panel shall be placed below each fiber optic patch panel installed by the Contractor. Additional jumper management panels may be required pending installation of other cable types on the rack. The rack shall be grounded to the telecommunications grounding backbone (TGB) using a #6 AWG (or larger) insulated stranded copper conductor (GREEN jacket).

3.5 LADDER RACK RUNWAY

- A. Runway shall be installed in accordance with recognized industry practices, to ensure that the cable tray equipment complies with requirements of NEC, applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.
- B. Coordinate installation of runway with other electrical work as necessary to properly interface installation of wire basket runway with other work.
- C. Provide sufficient space encompassing runways to permit access for installing and maintaining cables.
- D. Test runways to ensure electrical continuity of bonding and grounding connections and to demonstrate compliance with specified maximum grounding resistance.

End of Section

PART 1 - GENERAL

1.1 SCOPE

- A. This section describes the products and execution requirements relating to telecommunications voice, data and video horizontal (station) cabling and termination components.
- B. Horizontal cabling is the cabling between the work area telecommunications outlet and the telecommunications room (TR). Horizontal cabling is often referred to as “station cabling”.
- C. The horizontal cabling system will consist of the following:
 - 1. Unshielded Twisted Pair (UTP) Cable
 - 2. Outlet Termination Modules (jacks)
 - 3. Horizontal Cable Testing Requirements
 - 4. Cable Pathway/Sleeve Requirements

1.2 RELATED WORK

- A. Section 27 00 00 – General Technology Requirements
- B. Section 27 05 00 – Communications General Requirements
- C. Section 27 05 23 – Pathways for Technology Systems
- D. Section 27 05 26 – Grounding and Bonding for Technology Systems
- E. Section 27 11 00 – Communications Equipment Rooms
- F. Section 27 13 00 – Communications Backbone Cabling
- G. Section 27 16 00 – Communications Connecting Cords
- H. Section 27 18 00 – Communications Labeling and Identification

1.3 DEFINITIONS

- A. Refer to Section 27 00 00 for additional definitions.

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 for additional requirements.

1.5 QUALIFICATIONS

- A. Refer to Section 27 00 00 for additional requirements.

1.6 PRE-CONSTRUCTION SUBMITTALS

- A. Refer to Section 27 00 00 for additional requirements.

1.7 CONSTRUCTION PROGRESS SUBMITTALS

- A. Refer to Section 27 00 00 for additional requirements.

1.8 CLOSEOUT SUBMITTALS

- A. Refer to Section 27 00 00 for additional requirements.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.2 CATEGORY 6 HORIZONTAL COPPER CABLES

- A. All cables and equipment shall be furnished, tested, installed and wired by the Contractor.
- B. All horizontal data cables shall terminate on modular patch panels in the telecommunications closet as specified on the Drawings.
- C. This specification defines the requirements for commercially available high performance OSP rated Category 6 cable.
- D. The cable design described herein shall exceed transmission performance of Category 6 cables.
- E. Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of the National Electrical Code, and meet the specifications of NEMA (low loss), UL 444, and ICEA. Conductor shall also conform to the requirements for solid annealed copper wire in accordance with ASTM B 3.
- F. All cables, termination components, and support hardware shall be furnished, tested, installed, and wired by the Contractor.
- G. IMPORTANT: Cable and termination components (jack, patch panel, wiring blocks) are specified to function as a system. The compatibility of the cable to be installed with the proposed termination components shall be recognized and documented by the termination component manufacturer.
- H. Manufacturers:
 - 1. Paige Datacom GameChanger OSP Shielded cable.

2.3 INFORMATION OUTLET

- A. General
 - 1. Station cables shall each be terminated at their designated workstation location in the connector types described in the subsections below. Included are modular jacks, faceplates, and surface mount raceway. The combined assembly is referred to as the Standard Information Outlet (SIO). These connector assemblies shall snap into a mounting frame.
 - 2. SIOs shall be mounted in new outlet boxes, where existing boxes are in place, on surface mount raceway typically in surface raceway with barrier, in floor mount interface boxes, or on power poles either currently owned or new.

3. The telecommunications outlet frame shall accommodate or incorporate the following:
 - a. A minimum of four (4) modular jacks, when installed on a wall-mounted assembly.
 - b. A mechanism for adjusting the surface plate to a plumb position.
 4. When multiple jacks are identified in close proximity on the Drawings. The Contractor shall determine the optimum compliant configuration based on the products proposed.
 5. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each SIO type for review by the Consultant.
- B. Modular Jack
1. Data jacks shall be non-keyed 8-pin modular jacks.
 2. Termination components shall be designed to maintain the cable's pair twists as closely as possible to the point of mechanical termination.
 3. Jacks shall utilize a four-layer printed circuit board to control NEXT.
 4. Jack housings shall fully encase and protect printed circuit boards and IDC fields.
 5. Modular jack contacts shall accept 2500 plug insertions.
 6. Modular jack contacts shall be formed flat for increased surface contact with mated plugs. These contacts shall be arranged on the PC board in two staggered arrays of four to maximize contact spacing and minimize crosstalk.
 7. Modular jack contacts shall be constructed of Beryllium copper for maximum spring force and resilience.
 8. Contact Plating shall be a minimum of 50 micro inches of gold in the contact area over 50 micro-inch of nickel, compliant with FCC part 68.5.
 9. Jack termination shall be 110 IDC, integral to the jack housing, laid out in two arrays of four contacts.
 10. Jacks shall utilize a paired punch down sequence. Cable pairs shall be maintained up to the IDC, terminating all conductors adjacent to its pair mate to better maintain pair characteristics designed by the cable manufacturer.
 11. Jacks shall utilize tin lead plated (60% tin/40%lead) phosphor bronze 110 insulation displacement contacts.
 12. Jacks shall terminate 22-26 AWG stranded or solid conductors.
 13. Jacks shall terminate insulated conductors with outside diameters up to .050".
 14. Jacks shall be compatible with single conductor 110 impact termination tools.
 15. Jacks shall be compatible with EIA/TIA 606 color code labeling and accept snap on icons for identification or designation of applications.
 16. Jacks shall be marked as either T568A or T568B wiring.
 17. Category 6 jacks shall be manufactured by:
 - a. Panduit

- i. Equipment Room/Telecommunications Room End (White)
 - ii. Panduit Mini-Com TX6 Plus UTP Jack Modules # CJ688TGWH
 - iii. Field End (White)
 - iv. Panduit Mini-Com TX6A Plus UTP Jack Modules. WiFi specific jack.
- C. Surface Mount Interface Box
1. Low profile, surface mount boxes shall incorporate recessed designation strips at the top for identifying labels. Designation strips shall be fitted with clear plastic covers.
 2. The box shall feature built-in cable management for both fiber and copper applications.
 3. Any unused jack positions shall be fitted with a removable blank inserted into the opening.
 4. Modular jacks shall have capability to incorporate spring-loaded shutter door for added protection from dust and other airborne contaminants. The dust cover shall be designed to remain with the jack assembly when the jack is in use.
 5. The box shall have the capability to incorporate optional magnets that can be internally mounted.
 6. Surface mount box shall be manufactured by modular jack manufacturer.

PART 3 - EXECUTION

3.1 TESTING

- A. Refer to Section 27 00 00 for additional requirements.

3.2 TWISTED PAIR TEST EQUIPMENT

- A. Test equipment used under this contract shall be from a manufacturer who has a minimum of five years' experience in producing field test equipment. Manufacturers shall be ISO 9001 certified.
- B. All test tools of a given type shall be from the same manufacturer and have compatible electronic results output. Test adapter cable shall be approved by the manufacturer of the test equipment. Baseline accuracy of the test equipment shall exceed TIA Level III, as indicated by independent laboratory testing.
- C. Test equipment shall:
1. Be capable of certifying Category 5E, 6 and 6A permanent links.
 2. Have a dynamic range of at least 100dB to minimized measurement uncertainty.
 3. Be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.
 4. Include S-band time domain diagnostics for NEXT and return loss.
 5. Be capable of running individual NEXT, return loss, etc., measurements in addition to AutoText.
 6. Include a library of cable types, stored by major manufacturer.
 7. Store at least 1000 Category 5e, 6 or 6A autotests in internal memory.
- D. The measurement reference plane of the test equipment shall start immediately at the output of the test equipment interface connector. There shall not be a time domain dead zone of any distance that excludes any part of the link from the measurements.

- E. The approved manufacturer of the test equipment is Fluke and JDSU/Viavi.

3.3 TRAINING

- A. Refer to Section 27 00 00 for additional requirements.

3.4 WARRANTY

- A. Refer to Section 27 00 00 for additional requirements.

3.5 STATION CABLING

- A. Information outlet cables with copper media (voice & data UTP and "TV" coax) shall be located as detailed on the Project Drawings.
- B. The Contractor shall utilize these documents in determining materials quantities and routing.
- C. Station cables shall be run to the information outlet from the telecommunications room serving each area in conduit, free-air above drop ceiling, in cable tray, and/or in modular furniture.
- D. The maximum station cable drop length for UTP cables shall not exceed 295 feet (90 meters) in order to meet data communications performance specifications. This length is measured from the termination panel in the wiring closet to the outlet and shall include any slack required for the installation and termination. The Contractor shall install station cabling in a fashion to avoid unnecessarily long runs.
- E. Contractor shall verify cable lengths comply with published standards; prior to installation of any horizontal cabling, this Contractor shall verify cable paths and confirm no horizontal cable will exceed 295 total feet. If it is determined that the cable will exceed 295', this Contractor shall route the cabling to another telecommunications room or determine shorter path so cables are under 295'. If this is not possible, the Contractor shall notify the Consultant prior to installation. Failure to do this step will not result in a change order from the Contractor.
- F. All cables shall be installed splice-free unless otherwise specified.
- G. During pulling operation, an adequate number of workers shall be present to allow cable observation at all points of duct entry and exit as well as the feed cable and operate pulling machinery.
- H. Avoid abrasion and other damage to cables during installation.
- I. All cable shall be free of tension at both ends. In cases where the cable shall bear some stress, Kellom grips may be used to spread the strain over a longer length of cable.
- J. Where installed free-air, installation shall consider the following:
 - 1. Cable shall run at right angles and be kept clear of other trades' work.
 - 2. Cables shall be supported according to code, using "J-hooks" anchored to ceiling concrete, walls, piping supports, or structural steel beams.
 - 3. Hooks shall be designed to maintain cable bend to larger than the minimum bend radius (typically 4x the cable diameter).
 - 4. Supports shall be spaced at a maximum 4-foot interval unless limited by building construction. If cable "sag" at mid-span exceeds 6 inches, another support shall be used.
- K. Cable shall never be laid directly on the ceiling grid.

- L. Cables shall not be attached to existing cabling, plumbing, or steam piping, ductwork, ceiling supports, or electrical or communications conduit.
- M. Manufacturers' minimum bend radius specifications shall be observed in all instances. Use of plastic cable ties is not acceptable. Cable bundles shall be neatly dressed with use of Velcro type straps.
- N. Cable sheaths shall be protected from damage from sharp edges. Where a cable passes over a sharp edge, a bushing or grommet shall be used to protect the cable.
- O. A coil of one foot in each cable shall be placed in the ceiling at the last support (e.g., J-hook) before the cables enter a fishable wall, conduit, surface raceway, or box. At any location where cables are installed into movable partition walls or modular furniture via a service pole, approximately 15 feet of slack shall be left in each station cable under 250 feet in length to allow for change in the office layout without re-cabling. These "service loops" shall be secured at the last cable support before the cable leaves the ceiling and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.
- P. To reduce or eliminate EMI, the following minimum separation distances from $\leq 480V$ power lines shall be adhered to:
 - 1. Twelve (12) inches from power lines of $< 5\text{-kVa}$
 - 2. Eighteen (18) inches from high voltage lighting (including fluorescent)
 - 3. Thirty-nine (39) inches from power lines of 5-kVa or greater
 - 4. Thirty-nine (39) inches from transformers and motors
- Q. All openings shall be sleeved and firestopped per prevailing code requirements upon completion of cable installation.

3.6 INFORMATION OUTLET

- A. Information outlets shall be flush mounted on wall-mounted boxes, in floor-mounted boxes, on surface raceway, or on modular furniture.
- B. Any outlets to be added where these conditions are not met shall be positioned at a height matching that of existing services or as directed otherwise by the Site Coordinator and the Consultant. Nominal height (from finished floor to center line of outlet) in new installation shall be as follows:
 - 1. Standard Voice & Data Outlet (SIO) shall match adjacent electrical outlets.
 - 2. Wall-Mounted Telephone Outlet (Standard Voice only) shall meet ADA requirements for both front and side reach access.
- C. The Contractor shall coordinate the style of the telecommunication outlets to be installed in the floor mount boxes and surface mount raceways with the Owner.

3.7 ELEVATOR INTERFACE

- A. The Contractor shall furnish and install an elevator interface box outside of the elevator equipment room.
 - 1. The Contractor shall provide an elevator telecommunications junction box located outside of the Elevator Machine Room, for interface of telecommunication cable to the elevator cab(s). This requirement complies with ANSI A17.1 code which prevents work within the Elevator Machine Room, other than specific elevator work.

2. Telecommunications J-box shall include a keyed lockable door. Additionally, the J-box shall have proper punch down blocks and data jacks suitable for terminating all cables within the J-box.
3. The Contractor shall provide any voice/data cables to this enclosure as required.
4. Electronics or cable for other systems such as security shall not be placed within this enclosure.
5. Coordinate exact location of elevator security junction box with the Elevator Contractor, Architect, and Consultant, prior to installation.
6. Cables entering the elevator telecommunications J-box and elevator equipment room shall be appropriately labeled by the Contractor, so that the Elevator Contractor can connect the appropriate wires to the elevator controllers. Wires should be individually labeled to separate them from other elevator functions and to assist the Elevator Contractor in making proper connection points.

3.8 CABLE TERMINATION

- A. At the telecommunication closet, all data and voice cables shall be positioned on termination hardware in sequence of the outlet ID, starting with the lowest number.
- B. Termination hardware (blocks and patch panels) positioning and layout will be reviewed and approved by the Consultant prior to construction. The review does not exempt the Contractor from meeting any of the requirements stated in this document.
- C. Cable Termination – Data/Voice UTP
 1. Data/voice patch panels shall be designed and installed in a fashion as to allow future station cabling to be terminated on the panel without disruption to existing connections.
 2. Data patch panels shall be sized to accommodate a minimum of 20% growth in the quantity of stations relative to the initial installation.
 3. At information outlets and data/voice patch panels, the installer shall ensure that the twists in each cable pair are preserved to within 0.5 inch of the termination for data/voice cables. The cable jacket shall be removed only to the extent required to make the termination.
- D. Cable Termination – Fiber Optic
 1. All fibers shall be terminated using the specified connector type.
 2. All terminated fibers at the telecommunications closets shall be mated to couplings mounted on patch panels. Couplings shall be mounted on a panel that, in turn, snaps into the housing assembly. Any unused panel positions shall be fitted with a blank panel inhibiting access to the fiber optic cable from the front of the housing.
 3. All couplings shall be fitted with a dust cap.
 4. Fibers from multiple locations may share a common enclosure, but they shall be segregated on the connector panels and clearly identified. Fibers from multiple destinations may be secured in a common enclosure, provided they are clearly identified as such. Fibers from different locations shall not share a common connector panel (e.g., "insert").
 5. Slack in each fiber shall be provided as to allow for future re-termination in the event of connector or fiber end-face damage. Adequate slack shall be retained to allow termination at a 30" high workbench positioned adjacent to the termination enclosure(s). A minimum of one meter (~39") of slack shall be retained regardless of panel position relative to the potential work area.

6. If the cable is armored the Contractor shall install a plastic twist-on bushing on each end of interlocking armored fiber to protect cable from sharp edges of the armor.

3.9 TEST DATA – COPPER MEDIA

- A. The test result records saved by the tester shall be transferred into a Windows-based database utility that allows for the maintenance, inspection, and archiving of these test records. A guarantee shall be made that these results are transferred to the PC unaltered, i.e., “as saved in the tester” at the end of each test. Comma separated value (CSV) format is not acceptable.
- B. The database for the completed job – including twisted-pair copper cabling links, if applicable –shall be stored and delivered on CD-ROM. This CD-ROM shall include the software tools required to view, inspect, and print any selection of test reports.
- C. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information:
 1. The identification of the link in accordance with the naming convention defined in the overall system documentation.
 2. The overall Pass/Fail evaluation of the copper channel-under-test, including the NEXT worst-case margin (margin is defined as the difference between the measured value and the test limit value).
 3. The overall Pass/Fail evaluation of the fiber link-under-test, including the Attenuation worst-case margin (margin is defined as the difference between the measured value and the test limit value).
 4. The date and time the test results were saved in the memory of the tester.

3.10 COPPER STATION CABLES

- A. Station cabling testing shall be from the jack at the outlet in the work area to the patch panel on which the cables are terminated.
- B. Testing shall be of the permanent link. Contractor shall warrant performance, however, based on channel performance and provide patch cords that meet channel performance criteria. All cabling not tested strictly in accordance with these procedures shall be retested at no cost to the Owner.
- C. Testing shall be from the jack at the SIO to the patch panel on which the cables are terminated at the wiring hub.
- D. Horizontal “station” cables shall be free of shorts within the pairs and shall be verified for continuity, pair validity and polarity, and wire map (conductor position on the modular jack). Any defective, split, or mispositioned pairs shall be identified and corrected.
- E. Testing of the cabling systems rated at TIA Category 5e/6/6a and above shall be performed to confirm proper functioning and performance.
- F. Testing of the transmission performance of station cables (Category 5e/6/6a) shall include the following:
 1. Length
 2. Attenuation
 3. Pair to Pair NEXT
 4. ACR
 5. PSNEXT Loss

6. Return Loss
 7. Pair to Pair ELFEXT Loss or ACRF
 8. PSEFEXT Loss or PS-ACRF
 9. Propagation Delay
 10. Delay Skew
 11. Return Loss
- G. The maximum length of station cable shall not exceed 90 meters, which allows 10 meters for equipment and patch cables.
- H. Worst case performance at 20°C, based on a horizontal cable length of 90 meters and equipment cord length of 4 meters, shall be as follows:

1. CATEGORY 5e (Permanent LINK)

Frequency (MHz)	Insertion Loss (Maximum dB)	NEXT Loss Pair to Pair (dB)	PS-NEXT Loss (dB; Worst Case)	ELFEXT Loss Pair to Pair (dB)	PSELFEXT loss (dB)
1.0	2.1	>60.0	>57.0	58.6	55.6
4.0	3.9	54.8	51.8	46.6	43.6
8.0	5.5	50.0	47.0	40.6	37.5
10.0	6.2	48.5	45.5	38.6	35.6
16.0	7.9	45.2	42.2	34.5	31.5
20.0	8.9	43.7	40.7	32.6	29.6
25.0	10.0	42.1	39.1	30.7	27.7
31.25	11.2	40.5	37.5	28.7	25.7
62.5	16.2	35.7	32.7	22.7	19.7
100.0	21.0	32.3	29.3	18.6	15.6

2. CATEGORY 6 (Permanent LINK)

Frequency (MHz)	Insertion Loss (Maximum dB)	NEXT Loss Pair to Pair (dB)	PS-NEXT Loss (dB; Worst Case)	ELFEXT Loss Pair to Pair (dB)	PSELFEXT loss (dB)
1.0	1.9	65.0	62.0	64.2	61.2
4.0	3.5	64.1	61.8	52.1	49.1
8.0	5.0	59.4	57.0	46.1	43.1
10.0	5.5	57.8	55.5	44.2	41.2
16.0	7.0	54.6	52.2	40.1	37.1
20.0	7.8	53.1	50.7	38.2	35.2
25.0	8.8	51.5	49.1	36.2	33.2
31.25	9.8	50.0	47.5	34.3	31.3
62.5	14.1	45.1	42.7	28.3	25.3
100.0	18.0	41.8	39.3	24.2	21.2
200.0	26.1	36.9	34.3	18.2	15.2
250.0	29.5	35.3	32.7	16.2	13.2

3. CATEGORY 6a (Permanent LINK)

Frequency (MHz)	Insertion Loss (Maximum dB)	NEXT Loss Pair to Pair (dB)	PS-NEXT Loss (dB; Worst Case)	ACRF Pair to Pair (dB)	PS-ACRF (dB)
1.0	1.9	65.0	62.0	64.2	61.2
4.0	3.5	64.1	61.8	52.1	49.1
8.0	5.0	59.4	57.0	46.1	43.1
10.0	5.5	57.8	55.5	44.2	41.2
16.0	7.0	54.6	52.2	40.1	37.1
20.0	7.8	53.1	50.7	38.2	35.2
25.0	8.8	51.5	49.1	36.2	33.2
31.25	9.8	50.0	47.5	34.3	31.3
62.5	14.1	45.1	42.7	28.3	25.3
100.0	18.0	41.8	39.3	24.2	21.2
200.0	26.1	36.9	34.3	18.2	15.2
250.0	29.5	35.3	32.7	16.2	13.2
300.0	32.7	34.0	31.4	14.6	11.6
400.0	38.5	29.9	27.1	12.1	9.1
500.0	43.8	26.7	23.8	10.2	7.2

- I. In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacements, and changes as necessary and shall then repeat the test or tests that disclosed faulty or defective material, equipment, or installation method. The Contractor shall make additional tests as the Consultant deems necessary at no additional expense to the Owner or Consultant.
- J. All data shall indicate the worst-case result, the frequency at which it occurs, the limit at that point, and the margin. These tests shall be performed in a swept frequency manner from 1 MHz to highest relevant frequency, using a swept frequency interval that is consistent with TIA and ISO requirements. Information shall be provided for all pairs or pair combination and in both directions when required by the appropriate standards.
- K. Cables shall be tested to the maximum frequency defined by the standards covering that performance category. Transmission Performance Testing shall be performed using a test instrument designed for testing to the specified frequencies. Test records shall verify "PASS" on each cable and display the specified parameters—comparing test values with standards-based "templates" integral to the unit.

End of Section

PART 1 - GENERAL

1.1 SCOPE

- A. This section describes the products relating to high quality Category 6 voice and data patch cords.
- B. In this section the term patch cords refers to the cords that connect Owner provided data network electronics to the horizontal cable infrastructure.
- C. It is important that the horizontal cable system and the provided patch cords work as one complete system for guaranteed channel performance. Patch cords shall be manufactured by the same manufacturer as the jack and patch panels.
- D. The Contractor shall provide and deliver all cords as listed in this section. The Owner will be responsible for installation of cords.

1.2 RELATED WORK

- A. Section 27 00 00 – General Technology Requirements
- B. Section 27 05 00 – Communications General Requirements
- C. Section 27 05 23 – Pathways for Technology Systems
- D. Section 27 05 26 – Grounding and Bonding for Technology Systems
- E. Section 27 11 00 – Communications Equipment Rooms
- F. Section 27 13 00 – Communications Backbone Cabling
- G. Section 27 15 00 – Communications Horizontal Cabling
- H. Section 27 18 00 – Communications Labeling and Identification

1.3 DEFINITIONS

- A. Refer to Section 27 00 00 for additional definitions.

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 for additional requirements.

1.5 QUALIFICATIONS

- A. Refer to Section 27 00 00 for additional requirements.

1.6 PRE-CONSTRUCTION SUBMITTALS

- A. Refer to Section 27 00 00 for additional requirements.

1.7 CONSTRUCTION PROGRESS SUBMITTALS

- A. Refer to Section 27 00 00 for additional requirements.

1.8 CLOSEOUT SUBMITTALS

- A. Refer to Section 27 00 00 for additional requirements.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.2 CATEGORY 6 PATCH CORDS

- A. The Owner has the right to determine the final length of the patch cords after the contract is awarded.
- B. All patch cords shall be WHITE in color.
- C. In each IDF, furnish to the Owner at the time of substantial completion (1) 3' 28 AWG Category 6 modular non-booted patch cable plus (1) 1' 23 AWG OSP rated patch cable at the wireless access point end for bollards and AP1 pole and (1) 15' 23 AWG OSP rated patch cable at the wireless access point end for AP2 pole. Contractor shall provide an additional 25% extra of each type for each terminated cable as spares.
- D. All patch cords shall be round and consist of eight insulated, stranded copper conductors, arranged in four color-coded twisted pairs within a flame retardant jacket and be backwards compatible with lower performing categories. Modular patch cords shall utilize ISO termination method that is designed to reduce and control near-end cross talk (NEXT) and far end cross talk (FEXT) without compromising signal impedance.
- E. Both ends of the cord shall be equipped with modular 8-position (RJ45 style) plugs wired straight through with standards compliant wiring. All modular plugs shall exceed FCC CFR 47 part 68 subpart F and IEC 603.7 specifications, and have 50 micro inches of gold plating over nickel contacts. Cable shall be label-verifiable. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level. Patch cords shall have color-coded insert molded strain relief boot with a latch guard to protect against snagging. Additional color-coding shall be available by the use of snap-in icons.
- F. Patch cords shall be wired straight through. Pin numbers shall be identical at each end and shall be paired to match T568B patch panel jack wiring per ANSI/TIA/EIA-568-B. Patch cords shall be unkeyed.
- G. The manufacturer of the cords shall be the same as the manufacturer for UTP termination hardware (jacks & patch panels). Cords shall be highest quality patch cords available by connectivity manufacturer.
 - 1. Panduit
- H. The patch cords shall match the Category rating of the jack and cable it will be connecting to.

2.3 FIBER OPTIC PATCH CORDS

- A. Coordinate final length of the patch cords with the Owner. For purposes of the bid provide one (1) 3' patch cord for both each end, the network closet and the device ends. Owner has the right to revise patch cord lengths and quantities after the contract is awarded.
- B. All OS2 SM fiber optic patch cords shall:
 - 1. Be duplex 2-3mm tight buffer design with Yellow jacket.

2. Have LC-LC connectors with straight thru connectors (A-A Polarity).
3. Have 8-9-micron OS2 core.
4. Manufacture:
 - a. Panduit
 - b. Corning
 - c. Consult with ITSD product engineer

PART 3 - EXECUTION

3.1 TESTING

- A. Refer to Section 27 00 00 for additional requirements.

3.2 TRAINING

- A. Refer to Section 27 00 00 for additional requirements.

3.3 WARRANTY

- A. Refer to Section 27 00 00 for additional requirements.

3.4 ORDERING AND DELIVERY

- A. Prior to ordering patch cords the Contractor shall schedule meeting with Owner and Consultant to verify patch cord lengths, colors and quantities.
- B. Contractor shall coordinate delivery of patch cords with Owner. Contractor shall have list of delivered cords and shall have Owner sign delivery sheet at time of delivery.

End of Section

PART 1 - GENERAL

1.1 SCOPE

- A. This section describes the products and execution requirements relating to labeling of telecommunications cabling, termination components, and related subsystems. Covered systems include the following:
 - 1. Equipment room backboards and equipment racks
 - 2. Station cable and terminating equipment
 - 3. Telecommunications grounds and related components

1.2 RELATED WORK

- A. Section 27 00 00 – General Technology Requirements
- B. Section 27 05 00 – Communications General Requirements
- C. Section 27 05 23 – Pathways for Technology Systems
- D. Section 27 05 26 – Grounding and Bonding for Technology Systems
- E. Section 27 11 00 – Communications Equipment Rooms
- F. Section 27 13 00 – Communications Backbone Cabling
- G. Section 27 15 00 – Communications Horizontal Cabling
- H. Section 27 16 00 – Communications Connecting Cords

1.3 DEFINITIONS

- A. Refer to Section 27 00 00 for additional definitions.

1.4 REFERENCE STANDARDS AND CODES

- A. Refer to Section 27 00 00 for additional requirements.

1.5 QUALIFICATIONS

- A. Refer to Section 27 00 00 for additional requirements.

1.6 PRE-CONSTRUCTION SUBMITTALS

- A. Refer to Section 27 00 00 for additional requirements.

1.7 CONSTRUCTION PROGRESS SUBMITTALS

- A. Refer to Section 27 00 00 for additional requirements.

1.8 CLOSEOUT SUBMITTALS

- A. Refer to Section 27 00 00 for additional requirements.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.2 LABELS

- A. All labels shall be permanent and be machine generated (e.g., Brady or Panduit). No handwritten or non-permanent labels shall be allowed. Labels shall be Brady "I.D. Pro" or XC-Plus or Panduit self-laminating. Labeling on backboards and/or equipment racks may be pre-cut adhesive type.
- B. Characters on all labels shall be black printed on a white background.
- C. Label size shall be appropriate to the cable size(s), outlet faceplate layout, patch panel design, or other related equipment sizes and layouts.
- D. All labels to be used on cables shall be self-laminating, white/transparent vinyl, and be wrapped around the cable sheath. The labels shall be of adequate size to accommodate the circumference of the cable being labeled and properly self-laminated over the full extent of the printed area of the label.
- E. Labels used to identify innerduct carrying fiber optic cable shall be labeled with a durable yellow polyethylene tag that reads "CAUTION Fiber Optic Cable" and includes blank spaces for adding (1) fiber count and (2) destination information. An example of a compliant product is VIP Products' "Caution Write-On Coverall Tag."
- F. Manufacturer:
 - 1. Permanent Labels for Fiber Optic Cables
 - a. Brady
 - b. Panduit Self Laminating Labels
 - 2. Permanent Labels for Innerduct
 - a. Panduit Dome-Top Ty Marker
 - 3. Permanent Labels for Copper Cables
 - a. Panduit Self-Laminating Labels
 - 4. Permanent Labels for Backbone Fiber Optic Cables
 - a. Panduit Dome-Top Ty Marker
 - 5. Permanent Labels for Patch Panels
 - a. Panduit Component Label

PART 3 - EXECUTION

3.1 TESTING

- A. Refer to Section 27 00 00 for additional requirements.

3.2 TRAINING

- A. Refer to Section 27 00 00 for additional requirements.

3.3 WARRANTY

- A. Refer to Section 27 00 00 for additional requirements.

3.4 GENERAL

- A. The Contractor shall match the Owner's standard labeling scheme.
- B. Clean surfaces before attaching labels.
- C. Install all labels firmly. Labels attached to terminating equipment such as backboards, faceplates, 110 blocks, and patch panels shall be installed plumb and neatly on all equipment.

3.5 LABELING OF CABLING AND TERMINATION COMPONENTS

- A. Backboard and Equipment Racks
 - 1. Backboards and equipment racks shall be labeled by the Contractor identifying the telecommunication room. Additionally, equipment racks shall have an alpha character after the room number unique to that particular communications closet. For example, TR1-A would be the first rack in TR1.
 - 2. Character height shall be 1-inch (minimum).
- B. Cabling
 - 1. Horizontal cables shall have a machine generated wrap around cable label within 4" of each end of the cable. Label shall be clearly legible and meet TIA-EIA 606 standards. Character height shall be .25" (minimum).
 - 2. Voice/data/video backbone cables shall have a machine generated wrap around cable label within 12" of each end of the cable. Label shall be clearly legible and meet TIA-EIA 606 standard. Character height shall be .5" (minimum).

3.6 FIBER OPTIC BACKBONE, RISER CABLES, AND TERMINATION COMPONENTS

- A. All fiber optic backbone and copper (inter-building, riser, and tie) cables shall be identified AT BOTH ENDS with a designation that identifies where the opposite end of the same cable terminates (e.g., equipment room or telecommunications room I.D.). In addition, labeling of all fiber optic cables shall include the number of fibers in the cable.
- B. Each fiber optic termination panel shall be clearly labeled indicating the destination of the cable(s) and the fiber number of each fiber position. The cable identifiers are to be secured to (1) the side and (2) the front cover of the panel enclosure.

3.7 DATA PATCH PANELS

- A. All data patch panels shall be clearly labeled indicating the telecommunication room number, the data patch panel letter designation, and the data port number on the data patch panel (ports 1 through 48). Each telecommunication room shall start with data patch panel 'A' and continue through the alphabet.
- B. A data port schedule for each telecommunication room shall be created in spreadsheet format (Excel) with the telecommunication room number, data patch panel letter designations, data port numbers, and

room numbers identified in the spreadsheet. In addition, for each data patch panel port, a field shall be provided in the spreadsheet for the Owner to manage the cabling infrastructure by recording the device and any special notes pertaining to the room utilizing the data cable terminated to the port.

- C. Refer to Telecommunication "T" Series Project Drawings for standard information outlet faceplate and data & voice patch panel labeling scheme requirements. A sample of the data and voice port schedules is to be provided to the Owner, in the cable record book and in electronic format (Excel spreadsheet), with final documents provided on the Project Drawings.

3.8 FIBER OPTIC CABLES AND TERMINATION COMPONENTS

- A. All fiber optic cables, termination enclosures and connector panels, and splice closures shall be clearly labeled.
- B. In addition, labeling of all fiber optic cables shall include the number of fibers in the cable.
- C. Each fiber optic termination panel shall be clearly labeled indicating (1) the destination(s) of the cable(s) and (2) fiber number of each fiber position. The cable identifiers are to be secured to (1) the side and (2) the front cover of the panel enclosure.

3.9 GROUND SYSTEM LABELING

- A. All grounds shall be labeled as close as practical to the point of termination (for ease of access to read the label). Labels shall be nonmetallic and include the following statement: "WARNING: If this connector or cable is loose or must be removed, please call the building telecommunications manger." Refer to ANSI/TIA/EIA 606 for additional labeling requirements.

End of Section

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish all labor, materials, equipment and incidentals as shown, specified and necessary to complete the work of site preparation, erosion control, surface drainage, ground water control, construction of compacted fills, excavations, trenching, installation and removal of sheeting and bracing, backfilling and final site grading.
- B. This Section includes providing backfill materials for all trenches including select backfill, backfill, fill, granular embedment, and the satisfactory disposal of surplus and unacceptable materials.
- C. No classification of excavated materials will be made. Excavation includes all materials regardless of type, character, composition, moisture, or condition thereof.
- D. The Contractor shall perform all earthwork as specified in this Section. All trenching shall conform to the requirements of Section 31 50 00 – Excavation Support and Protection.
- E. Related Sections:
 - 1. Section 31 23 13 – Subgrade Preparation.
 - 2. Section 31 50 00 – Excavation Support and Protection.

1.2 REFERENCES

- A. Geotechnical Report: Geotechnical Engineering Study for Brackenridge Park Bond Improvements, San Antonio, Texas (ASA18-037-00) by Raba Kistner dated May 6, 2020.
- B. ASTM: American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103, U.S.A. All references are to current active standard.
 - 1. ASTM A36 – Standard Specification for Carbon Structural Steel.
 - 2. ASTM A328 – Standard Specification for Steel Sheet Piling.
 - 3. ASTM C33 – Standard Specification for Concrete Aggregates.
 - 4. ASTM D421 – Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants.
 - 5. ASTM D422 – Standard Test Method for Particle-Size Analysis of Soils.
 - 6. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - 7. ASTM D1140 – Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75- μ m) Sieve.
 - 8. ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil In-Place by the Sand-Cone Method.
 - 9. ASTM D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - 10. ASTM D2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
 - 11. ASTM D4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - 12. ASTM D4943 – Standard Test Method for Shrinkage Factors of Soils by the Wax Method.
 - 13. ASTM D6938 – Standard Test Method for In Place Density and Water Content of Soil and Soil Aggregate by Nuclear Methods (Shallow Depth).
- C. OSHA: Occupational Safety & Health Administration, 200 Constitution Ave., NW, Washington DC 20210.
 - 1. 29 CFR Part 1926 – Safety and Health Regulations for Construction.
- D. TxDOT: Texas Department of Transportation, 125 E 11th St, Austin, Texas 78701
 - 1. Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges, adopted by TxDOT June 1, 2014.
 - a. Item 160 – Topsoil.
 - b. Item 164 – Seeding for Erosion Control.
 - 2. Tex-104-E – Determining Liquid Limits of Soils.

3. Tex-106-E – Calculating the Plasticity Index of Soils.
4. Tex-110-E – Particle Size Analysis of Soils.
5. Tex-116-E – Ball Mill Method for Determining Disintegration of Flexible Base Material.
6. Tex-117-E – Triaxial Compression for Disturbed Soils and Base Materials.

1.3 SUBMITTALS

- A. Test Reports.
 1. The testing laboratory shall submit copies of the following reports directly to the Engineer, with copy to the Contractor:
 - a. Field Density Test.
 - b. Optimum Moisture – maximum density curve for each soil used as backfill.
- B. Samples of all select backfill, backfill, fill, granular embedment, pit run sand, and drain gravel, shall be submitted by the Contractor to the Testing Laboratory. Samples of the proposed material shall be submitted to least fourteen (14) days in advance of its anticipated use. Each material sample shall be submitted to the Testing Laboratory in three (3) five-gallon containers.

1.4 QUALITY ASSURANCE

- A. Testing Services.
 1. General:
 - a. Testing of materials, testing of moisture content during placement and compaction of fill materials, and of compaction requirements for compliance with technical requirements of the Specifications shall be performed by a testing laboratory. See Division 1 of Specifications.
 2. Testing Services Include:
 - a. Test the Contractor's proposed materials in the laboratory and/or field for compliance the Specifications.
 - b. Perform field moisture content and density tests to assure that the specified compaction of backfill material has been obtained.
 - c. Report all test results to the Engineer and the Contractor.
- B. Earthwork – perform sampling and testing as specified in this Section and Section 01 45 00 – Quality Control.
 1. Perform one moisture-density (Proctor) test per soil type subgrade, backfill, fill and base materials.
 2. Perform one Atterberg limits test per soil type subgrade, backfill, fill and base materials.
 3. Perform one percent finer than #200 sieve test per soil type subgrade, backfill, fill and base materials.
 4. In building areas refer to structural plans, notes, and specifications for requirements.
 5. In pavement areas provide:
 - a. One moisture-density test per 5,000 square feet of surface area on the subgrade soil.
 - b. One moisture-density test per 5,000 square feet of surface area for each compacted six inch (6") thickness of fill.
 - c. Failures in tested areas shall be re-tested until passed at the expense of the Contractor.
- C. Trench Backfill: Establish level of compaction effort by frequent testing of initial lifts. Provide not less than one (1) test per lift per 500 linear feet of trench.
 1. Make random tests of subsequent lifts of backfill. Frequency of tests shall be adequate to guarantee proper compaction. In no case shall there be less than one (1) test per lift per 500 linear feet of trench.
 2. Failures in tested areas shall be re-tested until passed at the expense of the Contractor.

1.5 SITE CONDITIONS

- A. Refer to Division 1 Specifications for information pertaining to availability of subsurface investigations.

- B. Contractor is referred to the Special Conditions and to other applicable sections of these Specifications in regard to protection of existing improvements and property shown to remain, as well as the proper barricading of all work areas.
- C. Erosion Protection: Provide erosion control as shown on the plans and maintain for the duration of the project. Provide routine maintenance as required to maintain integrity of erosion and sedimentation protection measures and remove any accumulations of mud or debris which would jeopardize the integrity of control measures. Refer to plans for details.
- D. Dust Control: The Contractor shall exercise care during site clearing operations to confine dust to the immediate work area and shall employ dust control measures to the satisfaction of the Owner to ensure adequate dust control throughout site clearing operations.
- E. Street Conditions:
 - 1. The Contractor shall be required to remove mud or debris from existing adjacent streets scheduled to remain in service throughout his contract period.
 - 2. The Contractor shall be responsible and protect the Owner from damage during haul operations. Any damage shall be repaired at the Contractor's expense.
- F. The use of explosives will not be permitted.
- G. Burning is prohibited.
- H. All traffic during construction shall confine their limits to an established "traffic route" submitted by the Contractor and reviewed by the Engineer.

1.6 COORDINATION

- A. The Contractor shall expedite placement of compacted fill and embankments at the earliest practical time.

1.7 LEGALLY PERMITTED LANDFILL CERTIFICATION

- A. The Contractor shall dispose of all materials in a legally permitted landfill, permitted to accept construction waste, as determined by the Texas Department of Health, Municipal Solid Waste Management Regulation
- B. The Contractor shall be required to provide written evidence of the permitted landfill prior to commencement of site clearing operations.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Backfill Materials.
 - 1. Materials for use as backfill shall be acceptable materials obtained from excavations on site; if material is obtained from off-site sources, their gradation shall not be more than 15% passing the No. 200 standard sieve as measured by ASTM D1140, and whose Plasticity Index (PI) is not in excess of 20 percent (20%) as determined by ASTM D4318. The material shall contain no vegetative matter.
 - 2. All material to be used as backfill shall be tested and verified by the Testing Laboratory.
- B. Fill Materials.
 - 1. Materials for use as fill shall be acceptable materials obtained from excavations on site; if material is obtained from off-site sources, their gradation shall not be more than 35% passing the No. 200 standard sieve as measured by ASTM D1140, and whose Plasticity Index (PI) is not in excess of 20 percent (20%) as determined by ASTM D4318. The material shall contain no vegetative matter.
 - 2. All material to be used as backfill shall be tested and verified by the Testing Laboratory.
- C. Select Backfill Material.
 - 1. Obtain select fill from a source that meets the requirements of the Geotechnical Report. In general, select fill shall consist of non-expansive (inert) soils such as a low plasticity clayey soil,

clayey gravel, crushed base material or caliche. Caliche used as select fill shall have a Plasticity Index (PI) between seven percent (7%) and twelve percent (12%).

2. Select fill for building areas shall meet the requirements of the Structural drawings and Section 03 30 00.
3. The select fill materials shall be free of organic debris and shall not contain stones larger than three (3) inches in maximum dimension.
4. All material for select backfill must be tested and accepted by the Testing Laboratory.
5. No select backfill shall be placed without authorization.
6. Select fill shall be defined as Grade 1-2, or Grade 3, adhering to the following physical requirements:
 - a. Clayey gravel materials shall be classified as crushed or uncrushed gravel.
 - b. Crushed base materials shall be produced from oversized quarried aggregate, sized by crushing and produced from a naturally occurring single source. Crushed gravel or uncrushed gravel shall not be submitted as crushed base material. No blending of sources and/or additive materials will be allowed.
 - c. Select fill shall meet the following physical requirements:

PROPERTY	TEST	GRADE 1-2	GRADE 3
Master Gradation Sieve Size (% retained)			
2-1/2 in.	Tex-110-E	-	0
1-3/4 in.	Tex-110-E	0-10	0-10
7/8 in.	Tex-110-E	10-35	-
3/8 in.	Tex-110-E	30-65	-
No. 4	Tex-110-E	45-75	45-75
No. 40	Tex-110-E	65-90	50-85
Liquid Limit, % max.	Tex 104-E	40	40
Plasticity Index, max.	Tex-106-E	10	12
Wet Ball Mill, % max.	Tex-116-E	40	-
Wet Ball Mill, % max. increase passing the No. 40 sieve	Tex-116-E	20	-
Classification	Tex-117-E	1.0	-
Min. Compressive Strength, psi			
Lateral Pressure 0 psi	Tex-117-E	35	-
Lateral Pressure 15 psi	Tex-117-E	175	-

- D. Granular Embedment Material.
 1. Granular embedment shall be as shown on the plans.
- E. Trench Plugs.
 1. Clay meeting the requirements of ASTM D2487 Classification of CL or CH and with at least 60 percent fines (passing No. 200 sieve) and a Plasticity Index of 15 or greater.
 2. Flowable fill.
 3. On-site silty sand soils processed with 20 pounds of bentonite clay per cubic yard.
- F. Herbicide.
 1. Comply with Federal Insecticide, Fungicide, and Rodenticide Act (Title 7, U.S.C. Section 136) for requirements on Contractor's licensing, certification and record keeping.
- G. Topsoil.
 1. Topsoil shall meet the requirements of TxDOT Item 160.
- H. Tree Wound Paint.
 1. Bituminous based paint of standard manufacture specially formulated for tree wounds.
- I. Tracer Wire for Nonmetallic Piping.

1. Tracer wire shall be minimum 12 gauge (AWG) single strand, insulated copper wire with high molecular weight polyethylene (HMWPE) insulation, specifically manufactured for direct burial applications.
 2. Provide tracer wire in sufficient length to be continuous over each separate run of non-metallic pipe.
 3. All spliced or repaired wire connections in the tracer wire system shall be made using approved connectors.
- J. Warning Tape.
1. Detectable underground aluminum warning tape shall be minimum 3 inches wide, minimum 5 mils thick. Tape to be color coded according to American Public Works Association (APWA) Uniform Color Codes.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Roads and Walks.
 1. Keep roads and walks free of dirt and debris at all times.
- B. Trees and shrubs.
 1. Protection shall be in accordance with project plans.
- C. Utility Lines.
 1. All existing utility locations shown on plans are approximate, based on information provided by utility service providers and field surveys. Utilities were not uncovered to determine precise locations, except as noted on the plans. The contractor shall verify the location of underground utilities and drainage structures at least forty-eight (48) hours prior to construction, whether shown on the plans or not, and shall protect same during construction.
 2. Protect existing utility lines that are not identified to be removed. Notify the ODR immediately of damage to or an encounter with an unknown existing utility line. The Contractor shall be responsible for the repairs of damage to existing utility lines that are indicated or made known to the Contractor prior to start of clearing and grubbing operations. When utility lines which are to be removed are encountered within the area of operations, the Contractor shall notify the ODR in ample time to minimize interruption of the service.

3.2 SITE PREPARATION

- A. Do not begin operations until limits of clearing and grubbing have been identified and staked out by the Contractor and approved by the Owner's Designated Representative.
- B. All areas of proposed construction shall be stripped of existing vegetation, concrete, asphalt and base, and six inches (6") of topsoil. Except as noted on the plans. Topsoil is to be stockpiled for reuse on the project, as noted below.
- C. Clear and grub all existing trees and understory where indicated on the drawings.
 1. A certified arborist shall perform all pruning. Contractor shall submit proof of qualifications and three (3) current references to Owner's Designated Representative for approval prior to commencing pruning.
 2. Remove all dead trees and tree limbs or trees that have substantial structural or cosmetic damage.
 3. Remove all climbing vines to a height of thirty feet (30') above the ground. Grub out vine roots.
 4. Remove all broken limbs and vines on trees that could fall and pose a hazard to pedestrians.
 5. Spray all Poison Ivy with two (2) applications of a contact herbicide labeled for such use. After a complete kill has been achieved, grub out all plants and roots. Do not burn any part of Poison Ivy plants.
 6. Remove briars and other vines and brambles where these plants have grown up into trees.
 7. Remove logs and stumps higher than four inches (4") above grade and other debris from this area. Backfill holes in accordance with this Section.

8. Trim tree limbs to allow five feet (5') clearance above ground.
 9. Remove any trash or man-made debris from this area.
 10. All material generated by pruning and clearing operations shall be disposed of legally off-site.
- D. General Stripping of Existing Weeds and Grasses:
1. The area within the work limits shown shall be stripped of lawns and vegetation under the direction of the Owner's Designated Representative.
 2. Method of removal shall remove a minimum amount of topsoil and shall be even so as to not generally change the overall grading.
 3. Remove and dispose of all products of stripping from the site. Do not allow material to accumulate at locations in or about the work areas.
- E. Stripping and Removal of Existing Sod:
1. All areas designated shall be stripped of existing sod to a depth of two and one-half inches (2 ½"), or as deep as necessary to remove the majority of roots.
 2. Sod shall be stripped by acceptable means and materials. Products of stripping operations shall be removed from the project area and be legally disposed of.
- F. Stripping and Stockpiling of Existing Topsoil:
1. Strip from all disturbed areas all suitable topsoil. Strip to a depth of four inches (4") or as necessary to remove all topsoil. Do not strip topsoil when conditions are muddy and avoid admixture with subsoil.
 2. Strip no topsoil where grades require only slight change.
 3. Stockpile the topsoil in areas designated on the Drawings or as agreed upon with the Owner. Stockpiled topsoil shall be free from trash and other related material and shall be protected during the duration of the Contract.
 4. Stripped and stockpiled topsoil not used for landscape fill or for planting operations shall be removed from the site and be legally disposed of.
- G. Any depressions created by site preparation operations shall be filled as directed below.

3.3 DEWATERING

- A. The Contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface and ground water entering excavations, trenches, or other parts of the Work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe is installed therein, and backfill operations have been completed.
1. The different working areas on the site shall be kept free of surface water at all times. The Contractor shall install drainage ditches and dikes and shall perform all pumping and other necessary work to divert or remove rainfall and all other accumulations of surface water from the excavations and fill areas. The diversion and removal of surface water shall be performed in a manner that will prevent the accumulation of water behind temporary structures or at any other locations within the construction area where it may be detrimental.
 2. Water used for working or processing, resulting from dewatering operations, or containing oils or sediments that will reduce the quality of the water downstream of the point of discharge shall not be directly discharged. Such waters shall be diverted through a settling basin or filter before being discharged.
 3. The Contractor will be held responsible for the condition of any pipe, conduit or channel which he may use for drainage purposes and all such pipes, conduits or channels shall be left clean and free of sediment.
- B. The Contractor shall provide, install and operate sufficient trenches, sumps, pumps, hose, piping, wellpoints, deep wells, etc., necessary to depress and maintain the ground water level below the base of the excavations during all stages of construction operations. The ground water table shall be lowered in advance of excavation and maintained two feet (2') below the lowest subgrade excavation made until structure has sufficient strength and weight to withstand horizontal and vertical soil and water pressures from natural ground water. The system must be operated on a 24-hour basis and standby pumping facilities and personnel shall be provided to maintain the continued effectiveness of

the system. If, in the opinion of the Engineer, the water levels are not being lowered or maintained as required by these Specifications, the Contractor shall install additional or alternate dewatering devices as necessary, at no additional cost to the Owner.

1. Elements of the system shall be located so as to allow a continuous dewatering operation without interfering with the construction of the permanent work. Where portions of the dewatering system are located in the area of permanent construction, the Contractor shall submit details of the methods he proposes to construct the permanent work in this location for the review of the Engineer. Control of groundwater shall continue until the permanent construction provides sufficient dead load to withstand the hydrostatic uplift of the normal groundwater, until concrete has attained sufficient strength to withstand earth and hydrostatic loads, until all waterproofing work below normal groundwater level has been completed, and until pipelines are properly jointed.
2. Dispose of all water removed from the excavation in such a manner so as not to endanger any portion of the work under construction or completed. Convey water from the excavations in a closed conduit. Do not use trench excavations as temporary drainage ditches. Before discontinuing dewatering operations, or permanently permitting the rise of the groundwater level, computations shall be made to show that any pipeline or structure affected by the water level rise is protected by backfill or other means to sustain uplift. Use a safety factor of 1.25 when making these computations.
3. Dewatering operations shall not be discontinued without the prior authorizations of the Engineer.

3.4 GRADING

- A. The site shall be prepared and shaped in conformity with the lines and grades as shown on the plans and the recommendations contained in the Geotechnical Report.

3.5 EXCAVATION

- A. General.
 1. The Contractor shall excavate and backfill, in advance of the construction, test pits to determine conditions or location of the existing utilities. The Contractor shall perform all work required in connection with excavating, stockpiling, maintaining, sheeting, shoring, backfilling and replacing pavement for the test pits.
 2. The Contractor shall be responsible for the definite location of each facility constructed by others involved within the area of his excavation for work under this contract. Care shall be exercised during such location work to avoid damaging and/or disrupting the affected facility. The Contractor shall be responsible for repairing, at his expense, damage to any structure, piping, or utility caused by his work.
 3. Excavation of every description and of whatever substance encountered within the limits of disturbance of the project shall be performed to the lines and grades indicated on the Drawings. All excavation shall be performed in the manner and sequence as required by the work.
 4. Excavation work shall be performed in a safe and proper manner with appropriate precautions being taken against all hazards. Excavations shall provide adequate working space and clearances for the work to be performed therein and for installation and removal of concrete forms. In no case shall excavation faces be undercut for extended footings.
 5. Exposed soil after excavations have been made shall be protected against detrimental damage and change in condition from physical disturbance and rain. Wherever possible, concrete footings shall be done the same day the excavation is made. If this is not done, the footing excavations shall be properly protected.
 6. All excavated materials that meet the requirements for backfill shall be stockpiled within the site, but not less the twenty-five feet (25') from the surface borders of any excavation, for use as backfill, or for providing final site grades. All excavated materials which are not considered suitable for fill, and any surplus or excavated material which is not required for fill shall be

- disposed of off the site by the Contractor. Upon completion of the fill, all on-site waste and disposal areas shall be cleaned and the debris removed from the site.
7. Materials deposited off the site shall be transported and placed in accordance with all applicable rules and regulations of all authorities having jurisdiction thereof. No surplus or unacceptable excavated materials of any kind shall be deposited in any stream or water course or dumped on public property.
- B. Excavation for Structures.
1. Excavations for construction of structures shall be carefully made to the depths indicated or required. Bottoms for footings and slabs shall be level, clean, dry and clear of loose material and the lower sections true to size.
 2. Subgrade preparation for structures shall meet the requirements of the Structural Drawings and Notes.
 3. Footings and slab excavations shall be verified by the Testing Laboratory, and reviewed by the Engineer, before concrete is placed thereon.
 4. In excavations for structures where, in the opinion of the Testing Laboratory, the ground, not affected by high water level, is spongy or otherwise unsuitable for the contemplated foundation, the Contractor will be required to remove such unsuitable earth and replace it with suitable material in accordance with the requirements of the Structural Drawings and Notes.
 5. Excavations for structures which have been carried below the depths indicated shall be refilled to the proper grade with select backfill material properly compacted in accordance with the Structural Drawings and Notes.
 6. All structure excavations shall be hand-trimmed to permit the placing of full widths and lengths of footings on horizontal beds. Rounded and undercut edges will not be permitted.
 7. Excavation shall be extended a minimum of two feet (2') on each side of structures, footings, etc., unless otherwise shown or specified.
- C. Excavation for Pavements.
1. Pavement excavation shall consist of excavations for all site pedestrian and vehicular pavements and pavers, in conformity with the typical sections shown on the Drawings, and to the lines and grades established by the Engineer and shown on the Drawings, by the removal of existing material or addition of acceptable material.
 2. All unstable or otherwise objectionable material shall be removed from the subgrade and replaced with acceptable material.
 3. All holes, ruts, and depressions shall be filled with select fill material.
 4. Subgrade preparation shall comply with the requirement of Section 31 12 13 – Subgrade Preparation.
- D. Trench Excavations.
1. Reference Section 31 50 00 – Excavation Support and Protection.
 2. Trenches shall be excavated to a width that will provide adequate working space and clearances for proper pipe installation, jointing and embedment.
 3. Where pipe elevations are not shown on the Drawings, trenches shall be excavated to a depth sufficient to provide a minimum cover of three feet (3') over the top of the pipe, unless otherwise shown or specified.
 4. Where necessary to reduce earth load on pipe trench banks to prevent sliding or caving, banks may be cut back on slopes that shall not extend lower than twelve inches (12") above the top of the pipe.
 5. Except where otherwise required, pipe trenches shall be excavated six inches (6") below or 1/8 of the outside diameter of the pipe, whichever is greater, the underside of the pipe to provide for the installation of granular embedment material.
 6. Over depth excavations shall be backfilled with select backfill material compacted to 95 percent (95%) of maximum density, as determined by ASTM D698 at a moisture content between optimum and optimum +4%.

7. Whenever subgrade material that is incapable of properly supporting the pipe is encountered, the subgrade material shall be removed to the depth required and the trench backfilled to the proper grade with select backfill material compacted to 95 percent (95%) of maximum density, as determined by ASTM D698 at a moisture content between optimum and optimum +4%.
8. Bell holes shall provide adequate clearance for tools and methods used in installing pipe. No part of any bell or coupling should be in contact with the trench bottom, trench walls, or granular embedment when the pipe is jointed.
9. Where existing piping constructed by others cross the new pipeline trench, the existing piping or ductbank shall be adequately supported and protected from damage due to construction. All methods of supporting and maintaining these facilities shall be subject to review by the Engineer and/or the Testing Laboratory.

3.6 UNAUTHORIZED EXCAVATION

- A. All excavation outside the lines and grades shown, and which is not in conformance with the plans and specifications as determined by the Testing Laboratory, together with the removal and disposal of the associated material shall be at the Contractor's expense.
- B. The unauthorized excavation shall be fill with select backfill and compacted as specified by the Testing Laboratory by the Contractor at his expense.

3.7 PLACEMENT OF FILL AND BACKFILL

- A. General.
 1. All select backfill, backfill and fill required for structures and trenches and required to provide the finished grades shown and as described herein shall be furnished, placed and compacted by the Contractor.
 2. Backfill excavations as promptly as work permits, but not until completion of the following:
 - a. Observation by the Engineer of construction below finish grade.
 - b. Observation, testing and recording of locations of underground piping and ductwork.
 - c. Removal of concrete formwork.
 - d. Removal of shoring and bracing, and backfilling of voids with satisfactory materials.
 - e. Removal of trash and debris.
 - f. Backfill against foundation walls only after review by the Engineer. Do not damage waterproofing when placing backfill.
 3. Fill containing organic materials or other unacceptable material shall be removed and replaced with acceptable fill material.
- B. Placement of Select Backfill, Backfill, and Fill Materials.
 1. Material shall be placed to the grades shown on the Drawings. The lift thickness and compaction moisture content range given herein are approximate. These values will be finally determined from the laboratory test results on the fill materials.
 2. All material shall be placed in horizontal loose lifts not exceeding nine inches (9") in thickness and shall be mixed and spread in a manner assuring uniform lift thickness after placing. Each lift shall be compacted by not less than two complete coverages of the specified compactor. Select backfill shall be placed to the underside of all concrete slabs. The fill material shall extend a minimum of two feet (2') outside the face of each structure and be twelve inches (12") below finished grade. The maximum slope of select backfill to the subgrade shall be one vertical to one and one-half horizontal.
 3. Backfill around and outside of structures and over select backfill shall be deposited in layers not to exceed nine inches (9") in uncompacted thickness and mechanically compacted, using platform type tampers. Compaction of structural backfill, by rolling will be permitted provided the desired compaction is obtained and damage to the structure is prevented. Compaction of select backfill and/or backfill by inundation with water will not be permitted. All materials shall be deposited as specified herein and as shown on the Drawings.
 4. All material shall be placed at a moisture content that falls in the range of laboratory optimum moisture content and laboratory optimum +4%. It shall be compacted to a density of 95 percent

(95%) of the maximum laboratory dry density for that material as determined by ASTM D698. The Contractor shall provide equipment capable of adding measured amounts of water to the material to bring it to a condition within the range of the required moisture content. The Contractor shall provide equipment capable of discing, aerating, and mixing the soil to insure reasonable uniformity of moisture content throughout the material and to reduce the moisture content of the material by air drying if necessary. If the subgrade material must be moisture conditioned before compaction, the material shall be sufficiently mixed or worked on the subgrade to insure a uniform moisture content throughout the lift of material to be compacted. Materials at moisture content in excess of the specified limit shall be dried by aeration or stockpiled for drying.

5. No material shall be placed when free water is standing on the surface of the area where the material is to be placed. No compaction of material will be permitted with free water on any portion of the material to be compacted. No material shall be placed or compacted in a frozen condition or on top of frozen material. Any material containing organic materials or other unacceptable material previously described shall be removed and replaced with acceptable material prior to compaction.
 6. Each lift of compacted material shall be compacted by the designated number of coverages of all portions of the surface of each lift by a smooth-drum vibratory roller for granular material having a static weight not less than 5,500 pounds, a sheepsfoot roller for cohesive material exerting a pressure of 250 psi on the surface of the feet, or equivalent equipment, prior to commencement of the work. One coverage is defined as the condition obtained when all portions of the surface of the backfill material have been subjected to the direct contact of the compactor. The compactor shall be operated at a forward speed not exceeding 40 feet per minute.
 7. Compaction shall be performed with equipment suitable for the type of material being placed. The contractor shall select equipment that is capable of providing the minimum density required by these Specifications. The gross weight of compacting equipment shall not exceed 7,000 pounds within a distance of ten feet (10') from the wall of any existing structure or completed structure under this contract. Equipment shall be provided that is capable of compacting in restricted areas next to structures and around piping. The effectiveness of the equipment selected by the Contractor shall be tested at the commencement of compacted material work by construction of a small section of material within the area where material is to be placed. If tests on this section of backfill show that the specified compaction is not obtained, the Contractor shall increase the amount of coverages, decrease the lift thicknesses or obtain a different type of compactor.
 8. Particular care shall be taken to compact structure backfill that will be beneath pipes, roads, or other surface construction or structures. In addition, wherever a trench passes through structure backfill, the structure backfill shall be placed and compacted to an elevation twelve inches (12") above the top of the pipe before the trench is excavated. Compacted areas, in each case, shall be adequate to support the item to be constructed or placed thereon.
 9. The compaction requirements specified are predicated on the use of normal materials and compaction equipment. In order to establish criteria for the placement of a controlled fill so that it will have compressibility and strength characteristics compatible with the proposed structural loadings, a series of laboratory compaction and/or compressive strength tests will be performed on the samples of materials submitted by the Contractor. From the results of the laboratory tests, the final values of the required percent compaction, the allowable compaction moisture content range, and the maximum permissible lift thickness will be established for the fill material and construction equipment proposed.
 10. The requirements of this Section apply for the placement and compaction of all fill materials.
- C. Backfill in Pipe Trenches.
1. Pipeline trenches may be backfilled prior to pressure testing, but no structure shall be constructed over any pipeline until it has been tested.

2. All pipe larger than six inches (6") in diameter shall be placed on granular embedment material. Pipe six inches (6") in diameter and smaller shall be placed in bedding zone of granular embedment material unless the trench bottom has been graded to provide uniform and continuous support of the installed pipe.
3. Backfill is divided into three (3) separate zones: (a) bedding, the material in trench bottom in direct contact with the bottom of the pipe; (b) initial backfill, the backfill zone extending from the surface of the bedding to a point one foot (1') above the top of the pipe; and (c) secondary backfill, the backfill zone extending from the initial backfill surface to the top of the trench. Placement of materials for each of the zones shall be as described herein.
 - a. Bedding.
 - 1) When unacceptable materials such as water, silt, muck, trash or debris, or rock boulder or coarse gravel (particle size greater than 1 ¾ inch) exist at the bearing level or for pipes with a nominal inner diameter greater than six inches (6"), a bedding of granular embedment material shall be used.
 - 2) Unstable materials shall be removed at the direction of the Engineer and replaced to a minimum depth of four inches (4") or one-eighth (1/8) of the outside diameter of the pipe, whichever is greater, with granular embedment material. This material shall extend up to the sides of the pipe sufficient to embed the lower quadrant of the pipe. If stability is not accomplished by using the above procedure, the Engineer may require additional granular embedment.
 - 3) Granular embedment shall be spread and graded to provide a uniform and continuous bedding zone beneath the pipe at all points between bell holes or pipe joints. It will be permissible to slightly disturb the finished subgrade surface to withdraw pipe slings or other lifting tackle. After each pipe has been graded, aligned, and shoved home, sufficient pipe embedment material shall be deposited and compacted under and around each side of the pipe and back of the bell or end thereof to hold the pipe in proper position and alignment during subsequent pipe jointing and embedment operations. Embedment material shall be deposited and compacted uniformly and simultaneously on each side of the pipe to prevent lateral displacement.
 - 4) Each layer of embedment material shall be compacted by at least two complete coverages of all portions of the surface of each lift using adequate compaction equipment. One coverage is defined as the conditions reached when all portions of the lift fill have been subjected to the direct contact of the compacting surface of the compactor.
 - 5) The method of compaction and the equipment used shall be appropriate for the material to be compacted and shall not transmit damaging shocks to the pipe.
 - b. Initial Backfill.
 - 1) Select Initial Backfill: Where pipe is to be laid in a rock cut or where rock in boulder ledge or coarse gravel (particle size larger than 1¾ inch) formations exist in the initial backfill zone, or where trench walls or conditions are unstable or where the pipe to be laid is flexible pipe, select initial backfill material shall conform to the requirements of Granular Embedment. For conduits less than twenty-four inches (24") in diameter select initial backfill material shall be placed in two (2) lifts. The first lift shall be spread uniformly and simultaneously on each side and under the shoulders of the pipe to the mid-point or spring line of the pipe. The first lift of select initial backfill shall be inspected and approved prior to placement of the second lift. The second lift of select initial backfill material shall extend from the spring line of the pipe to a depth sufficient to produce a compacted depth of material a minimum of one foot (1') above the top of the pipe. The second lift shall be evenly spread in a similar manner as the first lift. For conduits twenty-four (24") in diameter and larger, select initial backfill material shall be evenly and

- simultaneously spread alongside, under the shoulders or haunches of the pipe and over the pipe in twelve-inch (12") lifts to a point sufficient to produce a compacted depth of material a minimum of one foot (1') above the top of the pipe.
- 2) Optional Select Initial Backfill: Where the pipe to be laid is Flexible Pipe or where unstable materials exist at the pipe bearing level or the initial backfill zone, in lieu of the material specified above, an optional select backfill may be used by the Contractor where rock, in ledge, boulder, or coarse gravel (particle size larger than 1 ¾" inch) formations are not present in the bedding or initial backfill zone of the trench and where water is not present at the pipe bearing level. Optional Select Initial Backfill shall be clean, well graded gravels, crushed screenings or sand with 100% passing a ½" sieve, 95% to 100% passing a ¼" sieve. The plasticity index shall not be more than 12 when tested in accordance with the ASTM D4318. Optional select initial backfill shall be placed around the pipe and to the defined limit for initial backfill above. Sand and other materials as may be required by the Engineer shall be thoroughly compacted. Minimum thickness of completed optional select initial backfill shall be one foot (1') above the top of the pipe.
 - 3) Natural Initial Backfill: Where the pipe to be laid is rigid pipe and where stable materials and laying conditions exist at the pipe bearing level and initial backfill zone and existing excavated materials are acceptable to the Engineer, such excavated natural materials may be utilized as initial backfill material.
- c. Secondary Backfill.
- 1) Secondary backfill shall generally consist of materials removed from the trench and shall be free of trash brush and other debris. No rock or stones having any dimension larger than one half of the trench width, or eight inches (8"), unless otherwise approved, at the largest dimension, whichever is less, shall be used in the secondary backfilling zone. In special cases where excessive width and/or depth of the trench permit, and only with approval of the Engineer, larger rocks up to twelve inches (12") in diameter may be incorporated into the backfill provided that the surrounding compactable soil may be properly and adequately compacted. Material for backfill shall be placed in uniform layers not more than nine inches (9") in depth (loose measurement) and shall be compacted to the density specified herein.
 - 2) The initial lift of secondary backfill shall be a maximum of nine inches (9") in loose thickness. Consideration should be given to keeping the initial lift of secondary backfill as close as possible to the maximum nine inches (9") thickness to reduce the possibility of damage resulting from the compaction operations. This initial lift of secondary backfill material shall be compacted to a minimum of 95 percent of the laboratory determined maximum dry density (ASTM D698) using suitable compaction equipment. The backfill material shall be wetted or dried in such a manner as to provide uniform moisture content near the optimum moisture content identified by laboratory testing. Moisture contents in excess of 5 percent above or below the optimum laboratory moisture content are considered unacceptable and will require adjustment as necessary.
 - 3) Moisture density tests will be performed by a geotechnical engineer at periodic intervals on the top of the initial lift of backfill to determine the degree of compaction. If these test results indicate marginal compaction has been obtained near the surface of this lift, the Contractor will be given the option of applying more compactive effort or excavating a portion of the upper fill materials to allow access for moisture-density testing near the bottom of the lift. Any materials determined to be under compacted will require additional work by the Contractor to meet the above compaction requirements.

- 4) After the initial lift of secondary backfill has been properly compacted as evidenced by moisture-density tests, subsequent lifts of secondary backfill material shall be placed and compacted in accordance with the above Specification. All subsequent lifts of secondary backfill shall be placed in loose lifts not to exceed twelve inches (12") in thickness and compacted in accordance with the above Specifications. Succeeding lifts of supplemental backfill may be placed only after completion of adequate moisture-density tests on backfill material already in place.
 - 5) Due to the rather large vertical displacement of backfill material, experienced by using thick lifts, it is anticipated that, in some areas, the final lift of backfill material could be approximately one foot (1') thick. Compaction of this last lift of backfill material may be accomplished in the manner described above, or by a combination of use of vibratory plate compaction equipment and conventional pneumatic or sheep-foot rollers.
4. Clay Plugs.
- a. A clay plug shall be installed on all utility trenches before they enter the building or go under a foundation.
 - b. The plug must be installed a distance of one (1) foot from the foundation.
- D. Pit Run Sand Placement: Pit run sand shall be placed and compacted to the limits shown on the Drawings.
- E. Drainage Gravel: Drain gravel shall be compacted in maximum twelve inch (12") lifts with a minimum of two passes of a hand operated vibratory plate compactor weighing between 150 and 500 pounds.
- F. Replacement of Unacceptable Excavated Materials: In cases where over-excavation for the replacement of unacceptable soil materials is required, the excavation shall be backfilled to the required subgrade with select backfill material and thoroughly compacted to 95 percent (95%) of ASTM D698, at a moisture content between optimum and optimum +4%, in layers not thicker than twelve inches (12"). Sides of the excavations shall be sloped in accordance to the maximum inclinations specified for each structure location.
- G. Compaction Density Requirements.
1. The Testing Laboratory shall perform tests necessary to provide data for selection of fill material and control of placement water content.
 2. The Testing Laboratory will perform field density tests at the completion of each lift to ensure that the specified density is being obtained. Number of tests shall be determined by the Testing Laboratory.
 3. If the tests indicate unsatisfactory compaction, the Contractor shall provide the additional compaction necessary to obtain the specified degree of compaction. All additional compaction work shall be performed by the Contractor at no additional cost to the Owner until the specified compaction is obtained. The work shall include complete removal of unacceptable (as determined by the Testing Laboratory) fill areas and replacement and re-compaction until acceptable fill is provided.
 4. The degree of compaction required for all types of fills shall be listed below. Material shall be moistened or aerated as necessary to provide the moisture content specified below:

UNCOMPACTED MATERIAL LOCATION	STANDARD	MAXIMUM REQUIRED DENSITY	LOOSE LIFT THICKNESS
Select Backfill	ASTM D698	98%	8 inches
Backfill Around Structures	ASTM D698	95%	8 inches
All Other Backfill	ASTM D698	95%	8 inches
Fill Roadway Embankment	ASTM D698	95%	8 inches
Roadway Subgrade	ASTM D698	95%	8 inches
Fill Pipe Trenches	ASTM D698	95%	8 inches

Granular Embedment Pipe Trenches	ASTM D698	95%	8 inches
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3.8 FINAL GRADE AND EMBANKMENTS

- A. To the extent available, backfill material from excavations shall be placed in accordance with this Section to final grades with a maximum compacted depth of six inches (6").
- B. After other outside work has been finished, and backfilling and embankments completed and settled, all areas on the site of the work which are to be graded shall be brought to a subgrade suitable with the indicated elevations, slopes, and grades with suitable excess excavation material. Final grades shall be within 0.1 foot of the finished grades shown on the Drawings.
- C. Final stabilization of non-paved areas shall comply with the requirements of TxDOT Item 164.

3.9 DISPOSITION OF SURPLUS MATERIAL

- A. All surplus materials shall be removed from the Owner's property and be disposed of in a legal manner.

3.10 PROTECTION OF UTILITIES AND PROPERTY

- A. The Contractor is referred to other portions of this Section, the Special Conditions and other Sections and/or Divisions within these Specifications for requirements concerning the protection of utilities, property and existing trees.
- B. Locate and identify all above and below grade utilities in advance of any excavation operations and/or activities. Stake and flag locations. Maintain and protect existing utilities thus identified. Notify A/E or Owner's Representative if concealed conditions affect work.

END OF SECTION

DIVISION 31

Earthwork

95% Construction Documents

SECTION 312219 - FINE GRADING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS: The Drawings, Division 0 and Division 1 apply to the Work in this Section.

1.2 SUMMARY

A. Section Includes

1. Machinery restrictions.
2. Excavation, filling and backfilling of on site material.
3. Subgrade preparation
4. Finished grading.
7. Drainage.

B. Related Sections

1. Section 015639; TEMPORARY TREE AND PLANT PROTECTION
2. Section 071700, BENTONITE WATERPROOFING
3. Section 310000; SITE EARTHWORK
4. Section 328400; LANDSCAPE IRRIGATION
5. Section 329113; SOIL PREPARATION, for soil testing requirements.
6. Section 329213; HYDROSEEDING
7. Section 329300; PLANTS

1.3 GENERAL PROVISIONS

- A. Finished grading shall be defined as machine and hand grading of existing soil that is currently rough graded that will be required to bring the grade to the required grades for seeding, shrub and groundcover beds.
- B. Additional fill materials shall generally be defined as topsoil as specified herein unless otherwise specified.
- C. Where practicable and as directed, the use of heavy machinery shall be kept to a minimum.

1.4 QUALITY ASSURANCE

- A. Soil Analysis: The Contractor shall obtain an agricultural soil analysis of topsoil taken from ten (10) areas of the site. These samples shall be submitted to an accredited and approved soils laboratory at Contractor's cost. Submit results of soil analysis to the Owner for review. The soil analysis shall include recommendations for amendments to the soil to produce optimum plant growth from the variety of plants and grasses proposed. Contractor shall provide these amendments. Reference Section 329119 SOIL PREPARATION.
- B. Work shall be performed by personnel trained and experienced in this work and shall be done under the direction of a superintendent on Contractor's staff.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Topsoil is material that is existing site soil or may be required for finish grading operations shall conform to the requirements included within this Section.
- B. General Qualifications for Topsoil:
Imported topsoil shall be considered as material conforming to the following minimum criteria:
 - 1. Natural, friable, loamy soil, typical of local topsoil which produces heavy vegetative growth, free from subsoil, weeds, sods, stiff clay, stones larger than 1", toxic substances, debris, or other substances which may be harmful to plant growth. Do not deliver in muddy condition.
 - 2. Acidity/Alkalinity: pH 6.0 to pH 7.5.
- C. Grading Analysis: 2" sieve, 100% minimum passing. Number 4 sieve, 90% minimum passing. Number 10 sieve, 80% minimum passing.
 - 1. Sand, Silt, and Clay Content (from ASSHTO M146):
 - a. Sand 20 to 75 percent.
 - b. Silt 10 to 60 percent.
 - c. Clay 5 to 30 percent.
 - 2. All topsoil shall be free from all herbicides and insecticides which might adversely affect subsequent growth of turf or plantings or which might otherwise contain materials toxic to humans and pets.
- D. Non-Conforming Material: The Contractor shall not be permitted to use on-site material which does not conform to the above minimum criteria for fine grade operations. At the discretion of the Owner's representative, such material can either be amended to meet the minimum requirements or shall be removed from the site and replaced with suitable material as specified herein.
- E. It shall be the Contractor's responsibility to verify that the existing topsoil conforms to these specifications. Topsoil determined to be non-conforming subsequent to the award of a contract shall not be means for extra compensation unless otherwise provided for herein.
- F. Refer to Section 3291103 SOIL PREPARATION for existing site and topsoil sampling, fertility analysis requirements and physical criteria.

2.3 SAND

- A. Shall be clean, washed Bank Sand. Sample shall be submitted for approval. Sand shall be used for minor finish grade corrections and shall not be permitted for grading purposes if the depth exceeds 1/2" to achieve the finished grade.

2.4 COMPOST

- A. Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

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1. Organic Matter Content: 50 to 60 percent of dry weight.
 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- B. Supplier – Natures Way (936) 321- 6990, The Ground Up (281) 970-0003, or approved equal.

PART 3 - EXECUTION

3.1 PREPARATION OF SUBGRADE

- A. The subgrade soil when at optimum soil moisture shall be loosened to a depth of 4" by disking or tilling and then graded to remove all ridges and depressions so that it will be everywhere parallel to the proposed finished grade. All stones over 1 1/2" in any dimensions, sticks, rubbish and other extraneous matter shall be removed during this operation. If soil clumps over 2" in diameter remain, then make additional passes with a harrow or other approved equipment to reduce below the 2" size. No heavy objects except rollers shall be moved over lawn areas after the subgrade soil has been prepared before topsoil is spread.
- B. On all grass areas, the finished surface of the topsoil shall conform to the finished grade and shall be free from hollows or other inequalities, stones, sticks and other extraneous matter.

3.2 FINE GRADING

- A. In areas to receive seeded, hydroseed and/or sodded lawns, this Contractor shall till, disc, or otherwise scarify the soil to a depth of 4" removing all clods, stones, and related material 1" or larger.
- B. In areas to receive seed mixes, the Contractor shall till, disc, or otherwise scarify the soil to a depth of 4" removing all clods, stones, and related material 1" or larger. Once subgrade has been prepared the contractor shall grade the soil with a harrow attachment (similar or equal to a York Rake) to their tractor leaving 2" tall furrows with equal width. The contractor must perform this task by grading with the contours. When performed correctly hand grading may be unnecessary. This will be determined by the Landscape Architect.
- C. This Contractor shall be responsible for minor adjustments to the finished subgrade if such treatment is required in the opinion of the Owner's representative.
- D. The Contractor may use machinery acceptable to the Owner's representative to complete most of the work to re-establishing finished grade.
- E. During the finished grading operations, all swales and additional swales that may be required to drain areas where there are existing plant materials, shall be finished. In general, all grade adjustments shall be made so there are no areas that will have standing water.
- F. To prevent excessive weed growth in the lawn areas, the Contractor should be prepared to immediately install the sod or seeding upon the completed and acceptable finished grade.
- G. Prior to installation of grass or groundcovers, contact Landscape Architect to inspect and approve finish grade.

- H. Unless indicated on the Drawings, grading resulting in ponding of water is not allowed
- I. If applicable, install compost soil amendment required for establishing new turf and/or native grasses by mixing thoroughly into top 4 Inches of existing soil.
- J. Fine grade and shape landscape berms to the satisfaction of the Landscape Architect. Adjust, remove and add top soil as necessary to provide and smooth contoured finish.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes furnishing all labor, materials, and equipment necessary for completing all subgrade preparation operations for pavement, drainage facilities and other improvements shown on the drawings associated with this project.

1.3 RELATED SECTIONS

- A. Section 31 00 00 – Site Earthwork

1.4 DEFINITIONS

- A. Prepared Ground Surface – Ground surface after completion of site clearing, scalping of sod, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.
B. Subgrade – Layer of existing soil after completion of clearing, grubbing, scalping to topsoil prior to placement of fill, structural fill, roadway structure or base for floor slab.
C. Proof Rolling – Testing of subgrade by compactive effort to identify areas that will not support the future loading without excessive settlement, and locate areas of instability.

1.5 REFERENCE STANDARDS

- A. The contractor shall comply with applicable provisions and recommendations of the following:
1. ASTM: American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103, U.S.A. All references are to current active standard/
 - a. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - b. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
 2. Geotechnical Report.

1.6 SUBMITTALS

- A. Provide certifications and laboratory analysis results for all fill materials proposed for use on the project, indicating conformity to the specifications and source of materials.
B. Perform, document and report the following quality control tests at the designated frequency in accordance with Section 01 45 00
 1. Submit two (2) copies of test reports of the moisture-density and compaction results for review.
 2. Comply with Submittal requirements outlined in Sections 01 33 00 and 01 45 00.

1.7 SITE CONDITIONS

- A. Environmental Requirements: Prepare subgrade when unfrozen and free of ice and snow.

1.8 SEQUENCING AND SCHEDULING

- A. Complete applicable work as specified in Section 31 00 00 – Site Earthwork prior to subgrade preparation.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Proof Rolling Equipment

1. The proof rolling equipment shall consist of not less than four pneumatic tired wheels, running on axles carrying not more than two wheels, and mounted in a rigid frame and provided with loading platform or body suitable for ballast loading. All wheels shall be arranged so that they will carry approximately equal loads when operating on uneven surfaces.
2. The proof roller under working conditions shall have a rolling width of from 8 feet to 10 feet, and shall be so designed that, by ballast loading, the gross load may be varied uniformly from 25 tons to 50 tons. The tires shall be capable of operating under the various loads with variable air pressure up to 150 pounds per square inch. Tires shall be practically full of liquid. (Tires shall be considered as being practically full when liquid will flow from the valve stem of a fully inflated tire with the stem in the uppermost position). The operating load and tire pressure shall be within the range of the manufacturer's chart. The Contractor shall furnish the A/E charts or tabulations showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of loadings for the particular tires furnished.
3. The proof roller shall be towed by a suitable crawler type tractor or rubber-tired tractor of adequate tractive capacity, or may be of the self-propelled type. A proof roller unit shall consist of either a self-propelled roller or combination of roller and towing tractor.
4. There shall be a sufficient quantity of ballast available to load the equipment to a maximum gross weight of 50 tons.
5. Rubber tired tractive equipment shall be used on base courses and asphalt pavements. Other type tractive equipment may be used on embankment subgrade. The heavy pneumatic tire roller unit shall be capable of turning 180 degrees in the crown width or operating in forward and reverse modes.
6. In lieu of the rolling equipment specified, the Contractor may, upon written permission from the A/E, operate other compacting equipment that will produce equivalent results in the same period of time as the specified equipment. If the substituted compaction equipment fails to produce the desired results within the same period of time as would be expected of the specified equipment, as determined by the A/E, its use shall be discontinued.

PART 3 - EXECUTION

3.1 GENERAL

- A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.
- B. Bring subgrade to proper grade and cross-section and uniformly compact surface.
- C. Do not use sections of prepared ground surface as hauls roads. Protect prepared subgrade from traffic.
- D. Maintain prepared ground surface in finished condition until next course is placed.
- E. The Contractor shall be responsible for providing accurate lines and grades of subgrade per drawings.

3.2 APPROVAL OF SUBGRADE

- A. Proof-Rolling: Proof-roll subgrade below the building pad and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
- B. Completely proof-roll subgrade in one direction, each succeeding trip of the proof roller shall be offset by not greater than one tire width. Repeat proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
- C. Remove soft spots down to firm soil, minimum 12 inches deep, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by A/E representative, fill with select structural fill in maximum 8 inches deep lifts, and compact as specified.

3.3 MOISTURE CONDITIONING

- A. Dry Subgrade: Add water, then mix to make moisture content uniform throughout.

- B. Wet Subgrade: Aerate material by blading, disking, harrowing, or other methods, to hasten drying process.

3.4 QUALITY CONTROL TESTING

- A. Provide certifications and laboratory analysis results for all fill materials proposed for use on the project, indicating conformity to the specifications and source of materials.
- B. Engage a testing laboratory for control testing during subgrade preparation operations to perform, document and report the following quality control tests at the designated frequency in accordance with Section 01 45 00.
 - 1. Perform laboratory density tests in accordance with ASTM D698.
 - 2. Field density tests may also be performed by the nuclear method in accordance with ASTM D6938, provided that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D698. When field in-place density tests are performed using nuclear methods, make calibration checks of both density and moisture gages at beginning of work.
 - 3. Perform at least one field in-place density test for each 5,000 square feet.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Excavating for building volume below grade, footings, pile caps, slabs-on-grade, paving, site structures, and utilities within the building.

1.2 RELATED REQUIREMENTS

- A. Geotechnical report; bore hole locations and findings of subsurface materials.
- B. Section 312323.16 - Structural Fill: Fill materials, filling, and compacting.

1.3 PROJECT CONDITIONS

- A. Verify that survey bench mark and intended elevations for the Work are as indicated.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Locate, identify, and protect utilities that remain and protect from damage.

3.2 EXCAVATING

- A. Excavate to accommodate new structures and construction operations.
- B. Notify Architect/Structural Engineer of Record of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- C. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
- D. Do not interfere with 45 degree bearing splay of foundations.
- E. Cut utility trenches wide enough to allow inspection of installed utilities.
- F. Hand trim excavations. Remove loose matter.
- G. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 312323.
- H. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- I. Remove excavated material that is unsuitable for re-use from site.
- J. Remove excess excavated material from site.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for general requirements for field inspection and testing.
- B. Provide for visual inspection of load-bearing excavated surfaces before placement of foundations.

3.4 PROTECTION

- A. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.
- B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Filling, backfilling, and compacting for building volume below grade.

1.2 RELATED REQUIREMENTS

- A. Geotechnical report; bore hole locations and findings of subsurface materials.
- B. Section 312316.16 - Structural Excavation: Removal and handling of soil to be re-used.

1.3 REFERENCE STANDARDS

- A. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012.
- B. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2011.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Materials Sources: Submit name of imported materials source.
- C. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- D. Compaction Density Test Reports.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.

PART 2 PRODUCTS

2.1 FILL MATERIALS

- A. General Fill: Subsoil excavated on-site.
 - 1. Graded.
 - 2. Free of lumps larger than {CH#10000698}, rocks larger than {CH#10000699}, and debris.
 - 3. Conforming to ASTM D2487 Group Symbol .
 - 4. Plasticity Index (PI) maximum 20 percent, with moisture content between minus two (-2) and plus three (+3) points of the optimum.
- B. Structural Fill- Fill Type Item 247, Type "A", Grade 2: Conforming to State of Texas Highway Department standard.
- C. Granular Fill- Fill Type 57 Rock: Coarse aggregate, conforming to State of Texas Highway Department standard.

2.2 SOURCE QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for general requirements for testing and analysis of soil material.
- B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.
- C. If tests indicate materials do not meet specified requirements, change material and retest.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. In the area occupied by the foundation , plus a distance show on the drawings, remove topsoil including all organic materials, roots, etc. from the site per drawings. Do not use for underfloor fill. Remove additional material as necessary to provide minimum fill per drawings.

- B. The resulting surface shall be proof rolled with a sufficiently heavy roller (15 TONS) to locate and densify weak and compressible zones. A minimum of 6 passes of the roller is required. Any soft spots shall be removed and replaced with compacted structural fill.
 - C. The rolled subgrade shall be scarified just prior to fill placement to a minimum depth of 6" and recompacted to a minimum of 95% of the maximum density as determined by ASTM D 698 compaction test, maintaining moisture content between -1 and +3 percentage points until covered.
- 3.3 FILLING
- A. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches compacted depth.
 - B. Beginning at low end, build up to the bottom of the slab with structural fill. Refer to plan for minimum thicknesses. NO DIRT FILL SHALL BE USED UNDER THE BUILDING FOUNDATION. Submit written certification of compliance with requirements above by test performed on field sample.
 - C. All fill shall be placed in 8" loose horizontal lifts and compacted to a minimum of 95% of the maximum density as determined by ASTM D 698 compaction test.
- 3.4 FILL AT SPECIFIC LOCATIONS
- A. Under Interior Slabs-On-Grade:
 - 1. Use structural fill.
 - B. At Foundation Walls and Footings:
 - Use general fill.
 - 1. Fill up to subgrade elevation.
 - 2. Compact each lift to 90 percent of maximum dry density.
 - 3. Do not backfill against unsupported foundation walls.
 - 4. Backfill simultaneously on each side of unsupported foundation walls until supports are in place.
 - C. At Foundation Walls and Footings with concrete or paving above fill:
 - 1. Use Select Fill.
 - 2. Fill up to subgrade elevation.
 - 3. Compact each lift to 95 percent of maximum dry density.
 - 4. Do not backfill against unsupported foundation walls.
 - 5. Backfill simultaneously on each side of unsupported foundation walls until supports are in place.
 - D. Over Subdrainage Piping at Foundation Perimeter and Under Slabs:
 - 1. Drainage fill and geotextile fabric: Section 334600.
 - 2. Cover drainage fill with structural fill or flowable fill.
 - 3. Fill up to subgrade elevation.
 - 4. Compact to 95 percent of maximum dry density.
 - E. Over Buried Utility Piping, Conduits, and Duct Bank in Trenches :
 - 1. Bedding: Use sand.
 - 2. Cover with structural fill or flowable fill.
 - 3. Fill up to subgrade elevation.
 - 4. Compact in maximum 8 inch lifts to 95 percent of maximum dry density.
- 3.5 TOLERANCES
- A. Top Surface of General Filling: Plus or minus 1 inch from required elevations.
- 3.6 FIELD QUALITY CONTROL
- A. See Section 014000 - Quality Requirements, for general requirements for field inspection and testing.
- 3.7 CLEANING
- A. Leave unused materials in a neat, compact stockpile.
 - B. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.
 - C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.
- END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Terms and Conditions of the Contract, including Supplementary and Special Conditions of the Contract, and the Drawings apply to this Section.

1.2 SUMMARY

- A. Section includes furnishing and installing all equipment, materials, and labor for a trench safety system meeting appropriate requirements established in Occupational Safety and Health Administration (OSHA) Safety and Health Regulations, Part 1926, Subpart P - Excavations, Trenching, and Shoring.
- B. Related Sections:
1. Section 31 00 00 – Site Earthwork.
 2. Section 33 46 00 – Subdrainage.

1.3 REFERENCES

- A. ASTM: American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103, U.S.A. All references shall be to current active standard.
1. ASTM A36 – Standard Specification for Carbon Structural Steel.
 2. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
 3. ASTM A328 – Standard Specification for Steel Sheet Piling.
 4. ASTM A572 – Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
 5. ASTM A588 – Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance.
- B. American Welding Society (AWS). D1.1 - Structural Welding Code.
- C. United States Department of Labor Occupational Safety and Health Administration (OSHA). Part 1926, Subpart P, Code of Federal Regulations.

1.4 SUBMITTALS

- A. Submit drawings showing the design and details of proposed sheeting, shoring and bracing, and the proposed sequence of excavation and backfill to the Owner's Representative for review
1. The drawings shall be sealed by a registered professional engineer licensed in the State of Texas.
 2. Refer to the geotechnical study included with the bid documents for soil Classification, trench construction, trench shields, and trench shoring considerations.
 3. Do not begin construction of the sheeting, shoring, and bracing until the design and drawings have been reviewed.
 4. Review of the drawings by the Owner's Representative is for acceptance only insofar as it affects compliance with OSHA Regulations, and such acceptance will not relieve the Contractor of the responsibility from the adequacy of the design, or for compliance with OSHA regulations.

PART 2 - PRODUCTS

2.1 TIMBER

- A. Trench sheeting materials shall be a minimum of 2" in thickness, solid and sound, free from weakening defects such as loose knots and splits. Shoring timber sizes shall not be less than that called for in OSHA regulations.

2.2 STEEL SHEET PILING

- A. Steel sheet piling shall conform to the following specifications: ASTM A328 and ASTM A572, Grade 50

- B. Steel for stringers and cross braces shall conform to ASTM A588.

PART 3 - EXECUTION

3.1 GENERAL

- A. Trench safety system shall be constructed, installed and maintained in accordance with the OSHA regulations and to the design prepared by the Contractor's registered Professional Engineer to prevent death or injury to personnel or damage to structures in or near these trench excavations. Materials excavated from trench to be stored no closer to the edge of the trench than one-half the depth of the trench.

3.2 INSTALLATION

- A. Installation of trench safety system shall meet OSHA regulations and the Contractor's registered Professional Engineer's requirements.

3.3 SUPERVISION

- A. Contractor shall provide competent supervisory personnel at each trench while work is in progress to ensure Contractor's methods, procedures, equipment and materials pertaining to the safety systems in this item are sufficient to meet requirements of OSHA regulations.

3.4 MAINTENANCE OF SAFETY SYSTEM

- A. The safety system shall be maintained in the condition required by the OSHA regulations or as specified by the Contractor's registered Professional Engineer.
- B. The Contractor shall take all necessary precautions to ensure the safety systems are not damaged during their use. If at any time during its use a safety system is damaged, personnel shall be immediately removed from the trench or excavation area and the safety system repaired. The Contractor shall take all necessary precautions to ensure no loads, except those included in the safety system design, are imposed upon the excavation.

3.5 INSPECTION

- A. Contractor shall make daily inspection of trench safety system to ensure that the system meets OSHA requirements. Daily inspection to be made by competent personnel. If evidence of possible cave-ins or slides is apparent, all work in the trench shall cease until necessary precautions have been taken to safeguard personnel entering trench. Contractor to maintain permanent record of daily inspections.

3.6 REMOVAL

- A. Bed and backfill pipe to a point at least one foot above top of pipe prior to removal of any portion of trench safety system. Bedding and backfill to be in accordance to other applicable specification items. Backfilling and removal of trench supports shall progress together from bottom of trench upward. Remove no braces or trench supports until all personnel have evacuated the trench. Backfill trench to within 5 feet of natural ground prior to removal of entire trench safety system.

END OF SECTION

DIVISION 32

Sitework

95% Construction Documents

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes furnishing and installing flexible base for curbs and gutters, roadways, and parking areas as shown and detailed on the Drawings.

1.3 RELATED SECTIONS

- A. Section 31 00 00 – Site Earthwork
B. Section 31 23 13 – Subgrade Preparation
C. Section 32 12 16 – Asphalt Paving

1.4 REFERENCES

- A. American Society of Testing and Materials (ASTM), 1916 Race Street, Philadelphia, Pennsylvania 19103. All references shall be to current active standard.
1. ASTM C117 – Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
 2. ASTM D75 – Standard Practice for Sampling Aggregates
 3. ASTM D422 – Standard Test Method for Particle Size Analysis of Soils
 4. ASTM D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³))
 5. ASTM D2216 – Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
 6. ASTM D2487 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
 7. ASTM D4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
 8. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
- B. Texas Department of Transportation (TxDOT), 125 East 11th Street, Austin, Texas 78701
1. Tex-116-E – Ball Mill Method for Determining the Disintegration of Flexible Base Material.
 2. Tex-117-E – Triaxial Compression for Disturbed Soils and Base Materials
 3. Tex-140-E – Measuring Thickness of Pavement Layer

1.5 SUBMITTALS

- A. Test Reports: Submit two (2) copies of test reports of the physical properties of base material for review and approval by the Owner's Representative.
- B. Laboratory analysis of each base course material proposed demonstrating compliance with the requirements listed below in 2.1A. Utilize the following ASTM and TxDOT standard laboratory test procedures:
1. Moisture Content (ASTM D2216)
 2. Liquid Limit (ASTM D4318)
 3. Plasticity Index (ASTM D4318)
 4. Sieve Analysis (ASTM D422)
 5. Moisture-Density Determination (ASTM D1557)
 6. Roadway Density (ASTM D6938)
 7. Wet Ball Mill (Tex-116-E)
 8. Compressive Strength (TEX-11-E)

1.6 QUALITY ASSURANCE

- A. Obtain materials from same source throughout.
- B. Take samples for laboratory testing in accordance with ASTM D75.
- C. One optimum moisture-maximum density curve for each proposed material,

PART 2 - PRODUCTS

2.1 BASE COURSE

- A. Type A Base Course – Type A material shall be crushed stone produced and graded from oversize quarried aggregate that originates from a single, naturally occurring source. Crushed gravel or uncrushed gravel shall not be acceptable A material. No blending of sources and/or additive materials will be allowed in material
- B. Type E Base Course – Caliche.
- C. Base Course material shall meet the following criteria:

Property	Test Method	Grade 1-2
Master Gradation Sieve Size (% Retained)	ASTM D422	
2-1/2"		-
1-3/4"		0-10
7/8"		10-35
3/8"		30-65
No. 4		45-75
No. 40	65-90	
Liquid Limit (% Max.)	ASTM D4318	40
Plasticity Index (Max.)	ASTM D4318	10
Wet Ball Mill (% Max.)	Tex-116-E	40
Wet Ball Mill (% Max. Increase Passing No. 40 Sieve)	Tex-116-E	20
Minimum Compressive Strength (psi)		
Lateral Pressure 0 psi	Tex-117-E	35
Lateral Pressure 15 psi	Tex-117-E	175

- 1. The Engineer may accept material if no more than one (1) of the five (5) most recent gradation tests has an individual sieve outside the specified limits of the gradation.
- 2. The Engineer may accept material if no more than one (1) of the five (5) most recent plasticity index tests is outside the specified limit. No single test may exceed the allowable limit by more than 2 points.

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall provide and set all construction stakes as required by a Registered Professional Land Surveyor for the work required. All stakes shall be checked for conformity with the drawings and existing conditions. After approval of lines and grades the Contractor shall protect and maintain the approved stakes until they have served their purpose. Blue tops shall be set by the Contractor for subgrade on centerline, quarter points, and curb lines at intervals not exceeding 50 feet or 25 feet within curves.
- B. The subgrade shall have been compacted to a minimum of 95 percent density, to the typical sections, lines and grades shown on the drawings. The Contractor shall verify that the subgrade has been prepared and compacted in accordance with Section 31 23 13 by proof rolling. Any deviation shall be corrected, and proof rolled prior to placement of aggregate, and must be approved by the Owner's Representative. As soon as possible after the acceptance of the condition of the subgrade, the base course shall be installed.

3.2 PLACEMENT

- A. Placing: Flexible base shall be placed in eight-inch (8") courses maximum and in accordance with the following:
1. First Course
 - a. It shall be the responsibility of the Contractor to deliver the required amount of base material to each 100-foot station. Base material shall be spread uniformly and shaped the same day as delivered. In the event inclement weather or other unforeseen circumstances render this impractical, the material shall be shaped as soon as practical.
 - b. Prior to compacting the flexible base, the flexible base material shall be bladed and shaped to conform to the typical sections as shown on the plans. All areas of segregated coarse or fine material shall be corrected or removed and replaced with well-graded material, as directed by the Engineer and at the Contractor's expense.
 - c. The Contractor shall sprinkle for dust control as directed by the Engineer.
 2. Succeeding or Finish Courses:
 - a. Construction methods shall be the same as required for the first course. Throughout this entire operation, the shape of each course shall be maintained by blading. Upon completion, the surface shall be smooth and in conformity with the typical section as shown on the plans and the established lines and grades. Prior to placing the surfacing on the completed base, the base shall be cured to the extent directed by the Engineer.
 3. Compaction Method:
 - a. The flexible base shall be compacted to a minimum of 98% of the maximum dry density as determined by the modified Proctor test (ASTM D1557) and the moisture content shall be within plus or minus 1.5% of the optimum moisture content.
 - b. When the material fails to meet the density requirements, or it loses the required stability, density or finish before the next course is placed or the project is completed, it shall be reworked and retested in accordance with Section 3.2.A.4, below.
 4. Reworking a Section:
 - a. Should the base course, due to any reason or cause, lose the required stability, density or finish before the surfacing is complete; it shall be reworked, recompacted and refinished at the sole expense of the Contractor.
 5. Tolerances shall conform to the following:
 - a. Density Tolerances. The Engineer may accept the work providing not more than one (1) out of the most recent five (5) consecutive density tests performed is below the specified density, and providing that the failing test is no more than three (3.0) pounds per cubic foot below the specified density.
 - b. Grade Tolerances. In areas on which surfacing is to be placed, any deviation in excess of 1/4 inch in cross section or 1/4 inch in a length of 16 feet measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling.
 - c. Thickness Measurement. When the measurement is by the square yard, the flexible base will be measured for depth in units of 4000 square yards, or fraction thereof. The measurements will be at location(s) determined by the Engineer and performed in accordance with Test Method Tex-140-E. In any unit where flexible base is deficient by more than 1/2 inch in thickness, the deficiency shall be corrected by scarifying, adding material as required, reshaping, recompacting and refishing at the Contractor's expense.
- B. Spreading
1. Flexible base material deposited upon the prepared subgrade shall be spread, shaped and rolled the same day if possible. If not possible to do this within the first twenty-four hours (24), delay shall be held to a minimum. The base shall be wetted, bladed and rolled to achieve at least 98% compaction as determined by ASTM D1557. If the material fails to meet the density specified, it shall be re-worked as necessary to meet the density required.

- C. Deviation
 - 1. Any deviation in the finish surface in excess of 1/4" in cross-section or removing material, reshaping and recompacting by sprinkling or rolling. Any re-working of the base course required to conform to these specifications shall be at the cost of the Contractor.

3.3 QUALITY CONTROL TESTING

- A. Inspect and test each lift of base course. Do not place base for subsequent lifts until test results for the previously placed lift verify compliance with compaction requirements.
- B. Perform field density tests in accordance with ASTM D6938.
- C. Perform at least one field in-place density test for every 500 square feet, in no case shall be less than three (3) tests for any base course placement.
- D. Moisture-Density Relationship: One test of a representative sample of each day's delivery.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes furnishing and installing asphalt concrete paving including prime coat, tack coats, and related work as shown and detailed on the Drawings.

1.3 RELATED SECTIONS

- A. Section 31 00 00 – Site Earthwork
- B. Section 31 23 13 – Subgrade Preparation

1.4 DEFINITIONS

- A. Prime Coat – Prime coat is an asphalt binder applied to the finished base material to provide some waterproofing and to enable it to bond to a subsequent pavement layer (surface treatment or hot mix asphalt).
- B. Tack Coat – Tack coat is applied as a binder between layers of hot mix asphalt.

1.5 ACRONYMS

- A. AE-P – Asphalt Emulsion Prime
- B. C – Cationic
- C. CSS – Cationic Slow Setting
- D. EAP&T – Emulsified Asphalt Prime and Tack
- E. H (suffix) – Harder Residue (lower penetration)
- F. MC – Medium Curing
- G. PCE – Prime, Cure and Erosion Control
- H. SS – Slow Setting

1.6 REFERENCES

- A. American Society of Testing and Materials (ASTM), 1916 Race Street, Philadelphia, Pennsylvania 19103. All references shall be to current active standard.
 - 1. ASTM D946 – Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction.
 - 2. ASTM D977 – Standard Specification for Emulsified Asphalt
 - 3. ASTM D2027 – Standard Specification for Cutback Asphalt (Medium-Curing Type)
 - 4. ASTM D2397 – Standard Specification for Cationic Emulsified Asphalt
- B. Texas Department of Transportation (TxDOT), 125 East 11th Street, Austin, Texas 78701
 - 1. Standard Specifications for Construction of Highways, Streets and Bridges, TxDOT 2014 edition
 - a. TxDOT Item 300 – Asphalts, Oils, and Emulsions
 - b. TxDOT Item 340 – Dense-Graded Hot-Mix Asphalt

1.7 SUBMITTALS

- A. Contractor shall certify the mixing plant will conform to the requirements of TxDOT Item 340.
- B. Mix design reports for Type D mixture in accordance with TxDOT Method Tex-204-F.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Asphaltic Concrete Material shall be hauled in tight trucks previously cleaned of all dirt and foreign material with the load completely covered by canvas.

PART 2 - PRODUCTS

2.1 PRIME COAT

- A. Provide material meeting the requirements of one of the following:
1. MC-30 in accordance with ASTM D2027.
 2. AE-P meeting the requirements of TxDOT Item 300.
 3. EAP&T meeting the requirements of TxDOT Item 300.
 4. PCE meeting the requirements of TxDOT Item 300.

2.2 TACK COAT

- A. Provide material meeting the requirements of one of the following:
1. ASTM D977 emulsified asphalt, or ASTM D2397 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.
 2. CSS-1H meeting the requirements of TxDOT Item 300.
 3. EAP&T meeting the requirements of TxDOT Item 300.
 4. SS-1H meeting the requirements of TxDOT Item 300.

2.3 HOT MIX ASPHALTIC CONCRETE SURFACE COURSE

- A. The asphaltic concrete surface course shall be plant mixed, hot laid TxDOT Item 340 Type D (Fine Graded Surface Course) meeting the master specifications requirements in listed below. The mix is to be designed for a stability of 40 (minimum) when tested in accordance with TxDOT Test Method Tex-208-F. The asphalt cement content by percent of total mixture weight shall fall within a tolerance of -0.2 to +0.4 percent asphalt cement from the specific mix. The grade of asphalt cement shall be PG 64-22, ASTM D946. In addition, the mix shall be designed so that 75 to 85 percent of the voids in the mineral aggregate (VMA) are filled with asphalt cement. The coarse aggregate shall be crushed limestone, not gravel. Aggregates known to be prone to stripping should not be used in the hot mix. The mix shall have at least 70 percent strength retention when tested in accordance with Tex-531-C.

Master Gradation Bands (% Passing by Weight or Volume)	
Sieve Size	% Passing
3/4"	-
1/2"	98.0 – 100.0
3/8"	85.0 – 100.0
#4	50.0 – 70.0
#8	35.0 – 46.0
#30	15.0 – 29.0
#50	7.0 – 20.0
#200	2.0 – 7.0

2.4 HOT MIX ASPHALTIC CONCRETE BASE COURSE

- A. The asphaltic concrete base course shall be plant mixed, hot laid TxDOT Item 340 Type A (Coarse Base) or Type B (Fine Base) meeting the master specifications requirements in listed below. The mix is to be designed for a stability of 40 (minimum) when tested in accordance with TxDOT Test Method Tex-208-F. The asphalt cement content by percent of total mixture weight shall fall within a tolerance of -0.2 to +0.4 percent asphalt cement from the specific mix. The grade of asphalt cement shall be PG 64-22, ASTM D946. In addition, the mix shall be designed so to have a minimum 12.0 (Type A) or 13.0 (Type B) percent voids in mineral aggregate (VMA). Aggregates known to be prone to stripping should not be used in the hot mix. The mix shall have at least 70 percent strength retention when tested in accordance with Tex-531-C.

Type A Master Gradation Bands (% Passing by Weight or Volume)	
Sieve Size	% Passing
1 1/2"	98.0 – 100.00
1"	78.0 – 94.0
3/4"	64.0 – 85.0
1/2"	50.0 – 70.0
3/8"	-
#4	30.0 – 50.0
#8	22.0 – 36.0
#30	8.0 – 23.0
#50	3.0 – 19.0
#200	2.0 – 7.0
Type B Master Gradation Bands (% Passing by Weight or Volume)	
Sieve Size	% Passing
1 1/2"	-
1"	98.0 – 100.0
3/4"	84.0 – 98.0
1/2"	-
3/8"	60.0 – 80.0
#4	40.0 – 60.0
#8	29.0 – 43.0
#30	13.0 – 28.0
#50	6.0 – 20.0
#200	2.0 – 7.0

2.5 EQUIPMENT

- A. All equipment shall comply with the requirements below:
1. Asphalt Paver: Furnish a paver that will produce a finished surface that meets longitudinal and transverse profile, typical section, and placement requirements. Ensure paver does not support the weight of any portion of hauling equipment other than the connection. Provide loading equipment that does not transmit vibration or other motions to the paver that adversely affect the finished pavement quality. Equip the paver with an automatic, dual, longitudinal-grade control system and an automatic, transverse-grade control system.
 2. Tractor Unit: Supply tractor unit that can push or propel vehicles, dumping directly into the finishing machine to obtain the desired lines and grades to eliminate any hand finishing. Equip the unit with a hitch sufficient to maintain contact between the hauling equipment's rear wheels and the finishing machine's pusher rollers while mixture is unloaded.
 3. Screed: Provide a heated compacting screed that will produce a finished surface that meets longitudinal and transverse profile, typical section, and placement requirements. Screed extensions must provide the same compacting action and heating as the main unit unless otherwise approved.
 4. Grade Reference: Provide a grade reference with enough support that the maximum deflection does not exceed 1/16 in. between supports. Ensure that the longitudinal controls can operate from any longitudinal grade reference including a string line, ski, mobile string line, or matching shoes. Furnish paver skis or mobile string line at least 40 ft. long unless otherwise approved.

5. Material Transfer Devices: Ensure the devices provide a continuous, uniform mixture flow to the asphalt paver.
6. Remixing: When required, provide equipment that includes a pug mill, variable pitch augers, or variable diameter augers operating under a storage unit with a minimum capacity of 8 tons.
7. Motor Grader: When allowed, provide a self-propelled grader with a blade length of at least 12 ft. and a wheelbase of at least 16 ft.
8. Handheld Infrared Thermometer: Provide a handheld infrared thermometer meeting the requirements of Tex-244-F.
9. Straightedges and Templates: Furnish 10 ft. straightedges and other templates as required or approved.
10. Coring Equipment: When coring is required, provide equipment suitable to obtain a pavement specimen meeting the dimensions for testing.
11. Rollers: Pneumatic Tire Rollers – Pneumatic tire rollers consist of rubber wheels on axles mounted in a frame with either a loading platform or body suitable for ballast loading. Arrange the rear tires to cover the gaps between adjacent tires of the forward group. Furnish rollers capable of forward and backward motion, Compact asphalt pavements and surface treatments with a roller equipped with smooth-tread tires. Compact without damaging the surface. When necessary, moisten the wheels with water or an approved asphalt release agent. Select and maintain the operating load and tire pressure within the range of the manufacturer's charts or tabulations to attain maximum compaction. Furnish the manufacturer's charts or tabulations showing the contact areas and contact pressures for the full range of loadings for the particular tires furnished. Maintain individual tire inflation pressures within 5 psi of each other. Provide uniform compression under all tires.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Proof-roll prepared subbase and base course surfaces to check for unstable areas and areas requiring additional compaction or which have become wet beyond acceptable limits. Do not begin paving work until deficient areas have been corrected and are ready to receive paving.

3.2 PRIME COAT

- A. Conditions
 1. Prime coat shall not be applied when the air temperature is below 60 degrees F and falling, but it may be applied when the temperature is above 50 degrees F and is rising; the air temperature being taken in the shade and away from artificial heat.
- B. Preparation
 1. Clean the surface by sweeping with a vacuum sweeper or other approved methods as directed by the Engineer.
- C. Application
 1. Apply with an approved sprayer. Prime coat shall be applied at a rate not to exceed 0.20 gallons per square yard over compacted base material, smoothly and evenly, and shall be cured for 24 hours minimum. During the application of prime coat care shall be taken to prevent splattering of adjacent pavement, curbs, gutters or structures.

3.3 TACK COAT

- A. Maximum Lift Thickness – if the proposed hot mix asphalt thickness exceeds the maximums listed below, it will be installed in multiple lifts with tack coat applied between the lifts:
 1. Type A: 6.0"
 2. Type B: 5.0"
 3. Type D: 3.0"
- B. Preparation

1. Clean the surface by sweeping with a vacuum sweeper or other approved methods as directed by the Engineer.
- C. Application
 1. Apply with an approved sprayer. Tack coat shall be applied at a rate not to exceed 0.10 gallons per square yard over the surface, smoothly and evenly. All contact surfaces of curbs and surfaces and all joints shall be painted with a thin uniform coat of the tack coat material. During the application of prime coat care shall be taken to prevent splattering of adjacent pavement, curbs, gutters or structures.

3.4 SURFACE COURSE

- A. Conditions:
 1. The asphaltic mixture, when placed with a spreading and finishing machine, or the tack coat shall be placed when the air temperature is at least 50 degrees F.
 2. The asphaltic mixture, when placed with a motor grader, shall not be placed when the air temperature is below 55 degrees F and is falling, but may be placed when the air temperature is above 45 degrees F and is rising.
 3. The air temperature shall be taken in the shade and away from artificial heat.
 4. If, after being discharged from the mixer and prior to placing, the temperature of the asphaltic mixture falls below 200 degrees F, it will be rejected.
- B. The surface course shall be the thickness as shown on the drawings and spread in lifts with a maximum thickness of 3.0". Spread the lift in such a manner that when compacted, the finished course will be smooth, of uniform density, and to section, line and grade as shown on the drawings. All surface course placement shall meet the requirements of TxDOT Item 300.

3.5 ROLLING

- A. A Troxler nuclear density gauge shall be used to determine rolling pattern.
- B. Begin rolling while pavement is still hot and as soon as it will bear the roller without undue displacement or hair cracking. To prevent adhesion of surface mixture to the roller, keep wheels properly moistened with water. Excessive use of water will not be permitted. Complete compaction before mix temperature cools to 185 degrees F.
- C. Compress the surface thoroughly and uniformly, first with power-driven, 3-wheel, or tandem rollers weighing a minimum of 12 tons. Obtain subsequent compression by starting at the side and rolling longitudinally toward the center of the pavement, overlapping on successive trips by at least on-half width of rear wheels. Make alternate trips slightly different in length. Continue rolling until not further compression can be obtained and all rolling marks are eliminated.
- D. Use a tandem roller for the final rolling. Double coverage with an approved pneumatic roller on asphaltic concrete surface is acceptable after flat wheel and tandem rolling has been completed.
- E. All rolling compaction shall be completed before the mixture temperature drops below 175 degrees F.

3.6 HAND TAMPING

- A. Along walls, curbs, headers and similar structures, and in all locations not accessible to rollers, compact the mixture thoroughly with a vibrating plate compactor.

3.7 DENSITY

- A. Compact the surface course to the density between 91 and 95 percent of the maximum theoretical density as measured by TEX-207-F. If, during the construction, the results of density tests show that either the compacted base course, binder course or surface course has a density less than specified, an additional rolling with a 3-wheel or pneumatic roller will be required. Such a rolling shall be done before the mix cools if it is to be successful.

3.8 SURFACE TESTS

- A. The Contractor shall conduct surface testing. The completed surface, when tested with a 10-foot straightedge laid parallel to the center line of the pavement, shall show no deviation in excess of 3/16 inch per foot from the nearest point of contact. The maximum ordinate measured from the face of the straightedge shall not exceed 1/4 inch at any point. Furnish approved templates for checking subgrade in finished sections. The strength and rigidity of templates shall be such that if a support is transferred to center, no deflection in excess of 1/8 inch will be observed.

3.9 CONSTRUCTION JOINTS

- A. Place courses as nearly continuously as possible. Pass the roller over unprotected ends of the freshly laid mixture only when the mixture has become chilled. When work is resumed, cut back the laid material to produce a slightly beveled edge for the full thickness of the course. Remove old material which has been cut away and lay the new mix against the fresh cut.

3.10 DEFECTIVE PAVEMENT

- A. Recompact pavement sections not meeting specified densities or replace them with new asphaltic concrete material. Replace with new material section of surface course pavement not meeting surface test requirements or having an unacceptable surface texture. Patch asphalt pavement sections in accordance with procedures established by the Asphalt Institute. Replace asphalt pavement sections which did not meet the specifications.

3.11 DEFICIENT SURFACE THICKNESS

- A. Any area of asphalt surface found deficient in thickness by more than 0.25 inches, and if low and causing ponding, shall be removed and replaced, at the Contractor's expense, with asphalt surface of the thickness shown on the drawings. Care should be taken not to damage or remove the pavement below the asphalt surface. Should damage to the pavement below the asphalt surface occur, it shall also be removed and replaced at the Contractor's expense.
- B. No additional payment over the contract price will be made for any asphalt surface of a thickness exceeding that required by the drawings.

3.12 QUALITY CONTROL TESTING

- A. Perform document and report the following quality control tests:
1. Bulk specific gravity tests of the in-place, compacted bituminous mixtures in accordance with TxDOT Test Method Tex-207-F, Part I.
 2. For Type D mixture take three (3) cores for each 500 tons placed.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes Concrete Paving Including the Following:
 - 1. Walks.
 - 2. Curbs.
 - 3. Sub Slabs.
- B. Related Sections:
 - 1. Section 03 30 00 – Cast-In-Place Concrete.
 - 2. Section 07 92 01 – Exterior Joint Sealants.
 - 3. Section 31 00 00 – Site Earthwork.
 - 4. Section 31 23 13 – Subgrade Preparation.
 - 5. Section 32 14 40 – Stone Paving

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 REFERENCES

- A. Geotechnical Report: Geotechnical Engineering Study for Brackenridge Park Bond Improvements, San Antonio, Texas (ASA18-037-00) by Raba Kistner dated May 6, 2020.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to concrete paving, including but not limited to, the following:
 - a. Concrete mixture design.
 - b. Quality control of concrete materials and concrete paving construction practices.
 - 2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete paving Subcontractor.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. 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.

1.7 INFORMATIONAL SUBMITTALS

- A. Statement of Concrete Mix Design:
 - 1. Submit (1) copy of Statement of Concrete Mix Design prepared by concrete batch plant servicing Project for each concrete type identified on Drawings. Statement of Concrete Mix Design to shall contain minimum information for all of the components.
 - a. Concrete mix design number.

- b. Name, address, and telephone number of batch plant preparing Statement of Concrete Mix Design.
 - c. Date of mix design report.
 - d. Project location.
 - e. Contractor company name requesting concrete.
 - f. Integral color manufacturer, color name, and dosage rate.
 - g. Fine and coarse aggregate gradation chart.
 - h. Material weights, specific gravity, and absolute volumes.
 - i. Basis of testing such as UBC 2605 D4 or Title 24 2604 D4.
 - j. Water/cement ratio.
 - k. Admixtures including synthetic fibers.
 - l. PSI rating at 28 days.
 - m. Specific purpose of this concrete mix design such as "Paving Type 1".
 - n. Signature of testing laboratory manager.
- 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.
 - 6. Synthetic fibers
- C. Material Test Reports: For each of the following:
- 1. Aggregates: Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

1.8 QUALITY ASSURANCE

- A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M 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").
- B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
- 1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
 - 2. Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than 96 inches by 96 inches.
 - 3. Mock-ups shall be constructed where they do not interfere with the construction. Mock-ups shall remain on-site during construction.
 - 4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 5. Mock-ups shall not be considered part of the completed work and shall be removed once project is complete.

1.9 FIELD CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Cold-Weather Concrete 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.
- C. Hot-Weather Concrete Placement: Comply with ACI 301.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.2 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
 - 1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.
- 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.

2.3 REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
- B. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.
- C. 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.
- D. Synthetic Fibers for Historic Bridge Slab:
 - 1. 100% virgin polypropylene multifilament fibers added to concrete to reduce slab cracking caused by plastic shrinkage.
 - a. Application Rate: Per manufacturer's recommendations.
 - b. Acceptable Manufacturers:
 - 1) Fibermesh[®] 150 by Propex Fibermesh; www.fibermesh.com.
 - 2) MicroFiber[™] by Grace Construction Products; www.na.graceconstruction.com.
 - 3) UltraFiber[®] 500 by Buckeye Building Fibers; www.ultrafiber500.com.
 - 4) PSI Fiberstrand[™] 100 by Euclid Chemical; www.euclidchemical.com

2.4 CONCRETE MATERIALS

- A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
 - 1. Portland Cement: ASTM C 150/C 150M, gray portland cement Type I or Type II.
 - 2. Fly Ash: Not Permitted.
 - 3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.
- B. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 4S, 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. Exposed Aggregate (Top Cast Finishes): Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
 - 1. Lone Star Read Mix: LS30 PG3/8-L2-3000 PSI, 1"LS ,3/8"PG (2)
 - 2. 50% - 1" Limestone.
 - 3. 50% - 3/8" Pea Gravel.
- D. Air-Entraining Admixture: ASTM C 260/C 260M.

- E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. 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.
- F. Color Pigment: ASTM C 979/C 979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
 - 1. Color: As indicated on the drawings.
- G. Water: Potable and complying with ASTM C 94/C 94M.

2.5 CURING MATERIALS

- A. Water: Potable.
- B. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

2.6 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1752, cork or self-expanding cork in preformed strips.
- B. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Dayton Superior.
- C. Liquid Based Pigments:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Hydrotint as provided by Davis Colors.
 - 2. Color: As selected by Architect from manufacturer's full range.
- D. Joint Sealants: Acceptable sealants include, but not limited to:
 - 1. MasterSeal SL1 by BASF.
 - 2. Sikaflex-1A, by Sika Corporation.
 - 3. Eucolastic 1SL, by Euclid Chemical Company.

2.7 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, 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 comply with or exceed requirements.
- B. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use plasticizing and retarding admixture in concrete as required for placement and workability.
 - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- C. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.
- D. Concrete Mixtures: Normal-weight concrete.
 - 1. Compressive Strength (28 Days): 3000 psi.
 - 2. Maximum W/C Ratio at Point of Placement: 0.45.
 - 3. Slump Limit: 5 inches, plus or minus 1 inch.
- E. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. (0.60 kg/cu. M).

2.8 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M. Furnish batch certificates for each batch discharged and used in the Work.
 - 1. When air temperature is between 85 and 90 deg F, 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 subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
 - 1. Completely proof-roll subbase in one 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 31 23 13 – Subgrade Preparation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare subgrade as per Section 31 23 13 – Subgrade Preparation.
- B. Remove loose material from compacted subbase surface immediately before placing concrete.
- C. Moisten base as required to minimize absorption of water from fresh concrete. Do not permit puddles of water to accumulate.

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 INSTALLATION

- 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. 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 basin, manholes, inlets, structures, other fixed objects, and where indicated in the drawings.
 1. Extend joint fillers full width and depth of joint.
 2. Terminate joint fillers not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
 3. Place top of joint fillers flush with finished concrete surface if joint sealant is not indicated.
 4. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 5. During concrete placement, protect top edge of joint fillers with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch 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 2 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 2 inches either way from centers of dowels.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
- B. 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. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
- E. 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.
- F. 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.
- G. Screenshot paving surface with a straightedge and strike off.
- H. 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.
- I. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

- J. 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.

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.

3.9 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
 - 1. Elevation: 3/4 inch.
 - 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 - 3. Surface: Gap below 10-feet-long; unlevel straightedge not to exceed 1/2 inch.
 - 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.
 - 6. Vertical Alignment of Dowels: 1/4 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.
 - 9. Contraction Joint Depth: Plus 1/4 inch, no minus.
 - 10. Joint Width: Plus 1/8 inch, no minus.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C 172/C 172M 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/C 231M, 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 Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by 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 REPAIR 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 Architect.
- B. Drill test cores, where directed by Engineer, when necessary to determine magnitude of cracks or defective areas. Replace concrete panels with cores to match adjacent.
- 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

SECTION 321440 – STONE PAVING VENEER

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes materials, labor, apparatus, tools, equipment, temporary construction, transportation, and services necessary for and incidental to performing the proper completion of Work, as required, to make a complete, universally-accessible Unit Paving Veneer installation, mortar-set and grouted on a cast-in-place concrete substrate, as shown in the Contract Drawings, and as specified herein this Section.
- B. Work under this Section consists of, but is not necessarily limited to, furnishing and installing the following:
 - 1. Stone Unit Paving Veneer.
 - 2. Mortar Setting Bed.
 - 3. Grouted Joints.
 - 4. Accessories.
 - 5. Surface Sealant.
- C. Related Sections: The following Sections contain requirements that relate to Work in this Section:
 - 1. Section 033010 – Cast in Place Concrete - Sitework, for cast-in-place concrete substrate material.

1.2 DEFINITIONS AND APPLICABLE STANDARDS

- A. Percent Compaction: Per ASTM D1557, percentage of the maximum in-place dry density of the same material, as determined by the Geotechnical Engineer.
- B. Standard Specifications: Standard Specifications of the State of Texas, Business and Transportation Agency, Department of Transportation (TXDOT).
- C. References:
 - 1. ASTM – American Society for Testing and Materials.
 - 2. ANSI – American National Standards Institute.
 - 3. AASHTO – American Association of State Highway and Transportation Officials.
 - 4. BSI – Building Stone Institute.
 - 5. IBC – International Building Code.
 - 6. ADAAG – Americans with Disabilities Act Accessibility Guidelines.
- D. Material Specification Standards:
 - 1. ANSI A118.4 – Specification for Latex-Modified Thin-Set Portland Cement Mortar.
 - 2. ANSI A118.6 – Specification for Commercial Portland Cement Grout.
 - 3. ANSI A118.7 – Specification for Latex-Modified Portland Cement Grout.
 - 4. ASTM C568 – Standard Specification for Limestone Dimension Stone.
- E. Material Testing Standards:
 - 1. ASTM C97 – Standard Test Method for Absorption and Bulk Specific Gravity of Dimension Stone.

2. ASTM C99 – Standard Test Method for Modulus of Rupture of Dimension Stone.
3. ASTM C170 – Standard Test Method for Compressive Strength of Dimension Stone.
4. ASTM C199 – Standard Test Method for Pier Test for Refractory Mortars.
5. ASTM C241 – Standard Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic.
6. ASTM C780 – Standard Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
7. ASTM C880 – Standard Test Method for Flexural Strength of Dimension Stone.
8. ASTM C1019 – Standard Method for Sampling and Testing Grout.

1.3 SUBMITTALS

- A. General: Submit each item in this Article in digital PDF Submittal Booklets and provide four (4) sets of Material Samples for review by the Landscape Architect.
- B. Each Submittal Booklet under this Section shall be tabbed into specific sections, containing clearly identified (through yellow highlighter or other identification methods) and legible information on the following landscape information indicated in this Article.
 1. Material Data. Submit available product data, manufacturing source (name, address, and telephone number), and distributor source (name, address, and telephone number) for each type of material and product indicated herein this Article to the Landscape Architect.
 - a. Stone Unit Paving Veneer.
 - b. Setting Bed and Grouting Materials.
 - c. Accessories, as indicated herein this Section.
 - d. Finished Surface Sealer.
 - e. Slip Sheet.
 2. Qualification Data: Submit names for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience on similar Unit Paving Veneer projects. Include lists of completed projects with project names and addresses, reference names and addresses and the type of Unit Paving Veneer installed.
 3. Samples: Submit five (5) complete sample sets to the Landscape Architect for verification.
 - a. In full-size Units, submit Sample sets of each type of Unit Paving Veneer indicated herein this Section. Provide Sample sets of each size and shape for each color, texture, and pattern specified, showing the full range of variations expected.
 - b. 24 inch by 24 inch sample of the slip sheet.
- C. 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.
- D. Maintenance Program: Submit Manufacturer-recommended program for maintenance of each type of Unit Paving Veneer indicated herein.
- E. Material Test Reports: Submit test results from an independent testing laboratory for compliance of each type of Stone Paving Veneer specified, per associated ASTM standards.
 1. Test Units used for Unit Paving Veneer for compressive strength, absorption, and dimensional tolerance. Submit certified copies of field test of compressive strength, absorption, and dimensional tolerance.
 2. A minimum of three (3) full size Units per test are required for an average value.
 3. Cost of testing shall be borne by the Contractor or Manufacturer.

- F. Submittals shall be subject to rejection without review if they are difficult to read due to insufficient scale, poor image quality, or if all of the required information is not included within a single set of Submittals. Partial Submittals shall not be accepted.
- G. No Work under this Section shall proceed until all information indicated herein this Article have been reviewed, accepted, and approved by the Landscape Architect, in writing.

1.4 QUALITY ASSURANCE AND CONTROL

- A. **Manufacturer Qualifications:** Each Manufacturer shall specialize in the manufacturing of Stone Paving Veneer materials for a minimum of five (5) years.
- B. **Installer Qualifications:** Engage an experienced Installer who has completed Unit Paving Veneer installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance. Installation shall be by a Contractor and crew with at least two (2) years of experience in placing Unit Paving Veneer on projects of similar nature and dollar cost.
- C. **Single-Source Responsibility:** Obtain each color, type, and variety of Unit Paving Veneer type, joint materials, and setting materials from a single source with resources to provide products and materials of consistent quality in appearance and physical properties without delaying the Work.
- D. **Pre-installation Conference:**
 - 1. Before installing Work as indicated herein this Section, conduct a Pre-installation Conference at the Project Site with the Landscape Architect to review requirements and design objectives, including a review of textures, colors, finishes, layouts, and other design intents of the Work. Conference shall be held prior to erecting the Field-Constructed Mock-up Samples.
 - 2. Notify participants in writing at least five (5) working days prior to Conference.
- E. **Field-Constructed Mock-ups:** Prior to the installation of Work in this Section, erect Field-Constructed Mock-up to verify selections made under the Submittals Article and to demonstrate aesthetic effects as well as qualities of materials and execution for each stone paving pattern and type. Two or more mock-ups are to be expected to verify stone types. Build Field-Constructed Mock-ups to comply with the following requirements, using materials indicated for final Unit of Work, including same base construction, joints, and contiguous work as indicated.
 - 1. Locate Field-Constructed Mock-ups in the location and of the size indicated or, if not indicated, as directed by the Landscape Architect:
 - a. **Size:** Provide Field-Constructed Mock-up for each Unit Paving Veneer type indicated on the drawings. Alternate stone type not shown on the drawings maybe included for mock-ups. Each Mock-up shall measure 8'-0" wide x 10'-0" long, and include the edge restraint material at the perimeter of the Mock-up (where indicated per the Contract Drawings).
 - 2. Notify the Landscape Architect at least one (1) week in advance of the dates and times when the Field-Constructed Mock-up will be erected and ready for review.
 - 3. Demonstrate the proposed range of aesthetic effects and workmanship in the Field-Constructed Mock-up that will be produced in final unit of Work.
 - 4. Obtain the Landscape Architect's acceptance of the Field-Constructed Mock-up, in writing, prior to the start of the final Unit of Work. An accepted Mock-up is a prerequisite to commencing Work under this Section.
 - 5. Retain and maintain Field-Constructed Mock-ups during construction in an undisturbed condition. Accepted Field-Constructed Mock-ups shall be the standard for judging the completed Work under this Section.

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6. Demolish and remove the rejected Field-Constructed Mock-ups when directed by the Landscape Architect
 7. Accepted Field-Constructed Mock-ups may become part of the completed Work, if directed by the Landscape Architect.
 8. When the Landscape Architect determines that a Field-Constructed Mock-up does not meet requirements, retain it for reference and construct another Mock-up until it is accepted.
- F. Observation: Landscape Architect may observe installation of Unit Paving Veneer at Project Site for compliance with requirements for type, size, and quality. Landscape Architect retains right to observe Unit Paving Veneer for defects and to reject unsatisfactory or defective material at any time during progress of Work. Contractor shall remove rejected Work immediately from Project site.
- G. Manufacturer's Directions: Follow Manufacturer's directions and drawings in cases where the Manufacturers of articles used in this Section furnish directions covering points not shown in the Contract Drawings and Contract Specifications.
- 1.5 DELIVERY, STORAGE, AND HANDLING
- A. Provide new, unused materials indicated under this Section. Store and secure properly to prevent damage.
 - B. Deliver perishable material in original, unopened packaging. Protect from dampness.
 - C. Deliver materials in a timely manner so as to not delay Work, and install only after preparations for installation have been completed.
 - D. Protect materials during storage and construction against soilage or contamination from earth and other materials.
 1. Wrap Unit Paving Veneer materials in plastic or use other packaging materials that will prevent rust marks from steel strapping used in shipping.
 2. Deliver and unload materials at the Project Site in such a manner that no damage occurs to the products or materials.
- 1.6 COORDINATION, SCHEDULING, AND OBSERVATIONS
- A. Utilities: Determine location of above grade and underground utilities and perform Work in a manner which will avoid damage to utilities. Hand excavate, as required. Maintain grade stakes until removal is mutually agreed upon by parties concerned.
 - B. Excavation: When conditions detrimental to installing Unit Paving Veneer encountered, such as adverse drainage conditions, or obstructions, cease installation operations and notify Landscape Architect for further direction.
 - C. Grades and Levels: Establish and maintain required levels and grade elevations. Review installation procedures and coordinate Work herein this Section with other Work affected.
 - D. Installation: Perform installation of Unit Paving Veneer only when weather conditions are suitable in accordance with locally accepted practices. Do not install Unit Paving Veneer during rain or inclement weather, or while substrate is wet from rain.

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- E. Construction Site Observations: Periodic site observations shall be made by the Landscape Architect during the installation of Work under this Section. The Contractor shall request, in writing, at least one (1) week in advance of the time when mandatory site observation(s) by the Landscape Architect are required.

1.7 PROJECT SITE CONDITIONS

- A. Hot-Weather Requirements: Protect Work in hot weather by providing artificial shade, wind breaks and use cooled materials, as required.
- B. Grade Control: Establish and maintain required lines and elevations.
- C. Protect partially completed Veneer Unit Paving against weather damage when Work is not in progress.
- D. Traffic Control: Maintain access for vehicular, bicycle, and pedestrian traffic as required for other construction activities during installation of Veneer Unit Paving. Access shall also be unobstructed and maintained at all times to allow for entry and exit of emergency vehicles.

1.8 SEQUENCE AND SCHEDULING

- A. Acceptance: Do not install Work under this Section prior to acceptance of concrete substrate preparation under another Section.

1.9 EXTRA MATERIALS

- A. Provide additional Veneer Units to the Owner to be used for future repairs. Deliver surplus Units on pallets, as required, per the requirements of the Delivery, Storage and Handling Article.
 - 1. Quantity: Provide a minimum of one-percent (1%) of the total quantity installed of each Unit Paving Veneer in each respective Unit(s) size/color as indicated herein this Section.

1.10 SUBSTITUTIONS

- A. None. Due to the Historical requirements for this project. Provide stone types as shown on the drawing.
- B. Specific reference to Manufacturer's names and products specified herein are used as standards of quality. This implies no right to the Contractor to substitute other materials without prior written approval by the Landscape Architect for Work under this Section.
- C. Materials substituted and installed by the Contractor, without prior written approval by the Landscape Architect, may be rejected. Contractor shall not be entitled to be compensated by the Owner where the Contractor has installed rejected substitutions without receiving prior written approval.

PART 2 - PRODUCTS

2.1 STONE UNIT PAVING VENEER

- A. General: Provide materials and products that result in consistent colors, textures, and patterns of the Stone Veneer Pavement surfaces. Install in necessary quantity in areas as indicated on the Contract Drawings.
- B. Type: Solid, interlocking Stone Veneer Units, manufactured per in size, shape, color, texture, and other requirements, as indicated:
1. Reference Standards:
 - a. Meet ASTM C568 – Standard Specification for Limestone Dimension Stone.
 2. Testing and Physical Properties: Sample test Units prior to delivery. A minimum of five (5) specimens per test are required for an average value. Compile tests using full size Units, meeting the following:
 - a. Abrasion Resistance: Tested per ASTM C241 – Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic, with a Minimum Abrasion Resistance value of 8. Finished Stone Unit Paving surfaces under this Article shall be manufactured as “slip-resistant”, per ASTM F3445.
 3. Dimensional sizes: (as expressed in the ratio of length x width x thickness):
 - a. Refer to drawings.
 4. Non-Dimensional Sizes (random select flagstone).
 - a. Refer to drawings.
 5. Dimensional Tolerances:
 - a. Length or width: Units shall not differ by more than 1/16” from approved samples.
 - b. Height/Thickness: Units shall not differ by more than 1/16” from the specified standard dimensions.
 - c. Provide sound Stone Veneer Units free of defects that would interfere with proper placing of the Units or impair strength or permanence of construction. Minor cracks and minor chipping incidental to methods of manufacture, handling in shipment, and delivery will be acceptable subject to the Landscape Architect’s review and acceptance. Excessive cracks and chipping, as determined by the Landscape Architect will be rejected as not complying with the specification requirements.
 - d. Rejection: In the event the Units fail to conform to the specified testing requirements, the Manufacturer may sort it, and new test Units shall be selected at random by the Landscape Architect from the retained lot and tested at the expense of the Manufacturer. If the second test of test Units fails to conform to the specified requirements, the entire lot shall be rejected.
 6. Color(s):
 - a. Refer to Drawings for Color(s) to match the referee sample, as acquired by the Landscape Architect.
 7. Finish(es): Unless otherwise indicated, provide the following finishes in accordance with the Materials governing trade association:
 - a. Exposed surfaces shall have a Chiseled finish to match the referee sample; all other surfaces shall be sawn.
 - b. Exposed surfaces shall have a Natural Cleft finish to match the referee sample; all other surfaces shall be sawn.
 8. Patterns: Pattern of finished surface shall be in accordance to the layout as indicated in the Contract Drawings. Joint and maintain continuity of alignment that minimizes the need to sawcut

the Stone Veneer Units to fit in the allocated areas. No unknit is to be less than one third its original size.

9. Products & Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Alamo Stone, 4755 Alpine Road, Stafford TX 77474 (281) 240-4600, www.apexstone.com.

2.2 MORTAR

A. Thick-Bed Mortar:

1. General: Thick Bed Bonding Mortar shall be a factory-prepared, pre-mixed, dry-packaged, universal Thick Bed Mortar mix, specifically designed to eliminate lippage or shrinking, meeting ASTM C270 – Specification for Mortar for Unit Masonry. Mortar shall be subject to field-testing per ASTM C780 – Standard Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
2. Products & Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. #226 Thick Bed Mortar, Laticrete International, Inc., Bethany, CT.
 - b. Marble & Granite Fortified Premium Mortar, Custom Building Products, Seal Beach, CA.
 - c. MerPoxy 400, Mer-Krete Systems, Torrance, CA.

2.3 GROUT

- A. Standard: Meet ANSI A118.7 – Specification for Latex-Modified Portland Cement Grout and ASTM C476 – Standard Specification for Grout for Masonry, per ASTM C1019 – Standard Method for Sampling and Testing Grout.
- B. General: Grout shall be a factory-prepared, pre-mixed, dry-packaged, polymer-modified universal Grout Mixture, specifically designed to eliminate lippage or shrinking.
 1. Grout shall be comprised of an individually-packaged Grout Mixture and individually-packaged Latex Additive, that when combined together, create a Latex-Modified Grout that meets or exceeds the compressive strength and water resistance requirements of ANSI A118.7 – Specification for Latex-Modified Portland Cement Grout. Grout Mixture and Latex Additive shall be of the same Manufacturer.
- C. Products and Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 1. Grout Mixture:
 - a. Tri-Poly Fortified Sanded Grout (Series 1500), Laticrete International, Inc., Bethany, CT.
 - b. PolyBlend Sanded Grout, Custom Building Products, Seal Beach, CA.
 - c. #TA-650 AccuColor Premium Sanded Grout, TEC Specialty Products, Arlington Heights, IL.
 - d. Mer-Krete Sanded ColorGrout, Mer-Krete Systems, Torrance, CA.
 - e. or equal, as approved by the Landscape Architect.
- D. Color(s): Color(s) to be selected from the Manufacturer's full range of colors.
 1. Submit Manufacturer's grout color selections to Landscape Architect for selection.

2.4 CAST-IN-PLACE CONCRETE SUB-BASE/SUBSTRATE

- A. Per Section 033000; Cast in Place Concrete – Sitework.
 - 1. Provide finish as specified for concrete sub-base surfaces to receive Unit Paving Veneer.
 - 2. Provide concrete thickness and reinforcement requirements as indicated per the Contract Drawings.

2.5 ACCESSORIES

- A. Slip Sheet:
 - 1. General: The High Performance uncoupling mat shall have the flexibility and strength capable of withstanding up to a maximum of 1/8" horizontal structural crack and joint movement, and natural concrete shrinkage cracks up to 1/4", without transferring the stress load to the finished surface topping. Materials shall be compatible with selected mortar-based setting material.
 - 2. Products & Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. *Laticrete Strata Mat*, Laticrete International, Inc., Bethany, CT.
 - b. *Schulter Ditra Uncoupling Membrane*, Schluter Systems, (888) 472-4588.

2.6 SEALER

- A. General: Provide an invisible, penetrating sealer that protects the Unit Paving Veneer installation against stains, soiling, oil, discoloration, and efflorescence. Sealer shall be a clear, non-flammable, non-yellowing, solution which cures to reduce staining, water absorption, and acts as an invisible water-repellant coating.
- B. Products and Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. *Laticrete #190 Sealer*, Laticrete International, Inc.
 - 2. *Stone Sealant Impregnator*, Glaze 'N Seal.
 - 3. *TileLab SurfaceGard Penetrating Sealer*, Custom Building Products.
 - 4. *Sinak Sealer HLQ-125*, Sinak Corporation.
 - 5. *Atlas Outshine Sealer*, Atlas Tech Products.
 - 6. *Deep Sheen WB*, Prosoco, Inc.
 - 7. or equal, as approved by the Landscape Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces indicated to receive Unit Paving Veneer, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of Unit Paving Veneer. Do not proceed with installation until unsatisfactory conditions have been corrected.
 - 1. Where Unit Paving Veneer are to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations. Examine areas where waterproofing system is turned up or flashed against vertical surfaces as well as horizontal waterproofing. Do not proceed with installation until protection is in place.

3.2 FABRICATION

- A. Fabricate Unit Paving Veneer material in accordance with the tolerances as indicated.
 - 1. Unit Paving Veneer material shall be cut accurately to required shapes and dimensions.
 - 2. Holes, cut-outs, sinkages and openings in work for anchors, cramps, dowels, supports, and lifting devices shall be accurately cut or drilled to required dimensions, as shown on the approved Shop Drawings, and as necessary to secure Unit Paving Veneer material in place to ensure correct location and accurate fit of all fixtures. Setting beds shall be shaped to fit supports.
 - 3. Arrises shall be cut sharp and true to square, and continuous with adjoining arrises. Where exposed, arrises shall be erased.
- B. Flatness Tolerance: Variation from true plane, or flat surfaces, shall be determined by use of a 4 ft. long straightedge, applied in any direction on the surface. Such variations on polished, honed and fine rubbed surfaces at the bed and joint arris lines shall not exceed 3/64" or 1/16 of the specified joint, whichever is greater. On surfaces having other finishes, the maximum variation from true plane at the bed and joint arris lines shall not exceed 1/4 of the specified joint width.
- C. Variations from true plane on other parts of the face surfaces shall not exceed the following:
 - 1. Polished, honed or fine rubbed finishes: 3/64 in.
 - 2. Rubbed or fine stippled sandblasted finishes: 1/16 in.
 - 3. Shot ground, 8- and 6-cut finishes: 1/8 in.
 - 4. Thermal and coarse stippled sandblasted finishes: 3/16 in.
- D. Backs of pieces shall be sawn or roughly dressed to approximate true planes. Maximum variation in thickness from the specified shall not exceed the following:
 - 1. 1/4 in. on pieces up to modular 12 in. thick.
 - 2. 1/2 in. on pieces above 12 in. modular thick.

3.3 PREPARATION Allow Concrete Substrate to cure prior to application of Anti-Fracture/Crack Suppression Membrane.

- B. Remove substances from concrete substrates that could impair Anti-Fracture/Crack Suppression Membrane and/or Mortar bond, including curing and sealing compounds, form oil, and laitance. Vacuum clean to remove dirt, dust, debris, and loose particles.

3.4 INSTALLATION, GENERAL

- A. Do not use Unit Paving Veneer Units with chips, cracks, voids, discolorations, and other defects that might be visible or cause staining in finished Work.
- B. Mix Veneer Units from several pallets or cubes as they are placed to produce uniform blend of colors and textures.
- C. Cut Unit Paving Veneer Units, as required, with motor-driven masonry saw equipment to provide clean, sharp, un-chipped edges. Cut Units to provide pattern indicated and to fit adjoining Work neatly. Use full Units without cutting where possible. Hammer cutting is not acceptable.
- D. Joint Pattern: Match field-constructed Mockup, as indicated on the Contract Drawings.

- E. Veneer Units over Waterproofing: Exercise care in placing Unit Paving Veneer and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.
 - 1. Provide cork joint filler, where indicated, at waterproofing that is turned up on vertical surfaces; or if not indicated, provide temporary filler or protection until Veneer Unit Paving installation is complete.
- F. 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 paving.
- G. Expansion and Control Joints: Provide for sealant-filled joints at locations and of widths indicated. Provide cork joint filler as backing for sealant-filled joints where indicated. Install cork joint filler before setting Units.

3.5 MORTARED APPLICATIONS

- A. Apply Slip Sheet Membrane per the manufacturer's latest printed instructions. Once cured, flush concrete substrate with clean water several hours before placing Mortar Setting Bed. Remove surface water about one hour before placing Mortar Setting Bed.
- B. Thoroughly blend the Mortar Setting Bed materials per the manufacturer's latest printed instructions.
- C. Apply Mortar Setting Bed onto clean concrete substrate. Spread and screed accordingly to uniform thickness at sub-grade elevations required for accurate setting of Unit Paving Veneer to finished surface elevations as indicated.
- D. Mix and place only that amount of Mortar Setting Bed that can be covered with Veneer Units prior to initial set. Cut back, bevel edge, remove, and discard any Setting-Bed material that has reached initial set prior to placing Unit Paving Veneer.
 - 1. Where indicated, place reinforcing wire fabric over membrane protection course, lapped at joints by at least one full mesh and supported so that the mesh becomes embedded in the middle of setting bed. Do not butt edges against vertical surfaces.
- E. Wet Unit Stone Paving Veneer Units prior to laying if the initial rate of absorption exceeds 30 g/30 sq. in per minute when tested per ASTM C67. Allow Units to absorb the water so that they are damp but not wet at the time of laying.
- F. Place Unit Paving Veneer before initial set of Mortar Setting Bed occurs. Immediately prior to placing pavers on green or wet setting bed, apply uniform 1/16-inch thick slurry bond coat to bed or to back of each Unit with a flat trowel.
- G. Tamp and beat Unit Paving Veneer accordingly, as required, with a wooden block or rubber mallet, to obtain full contact with the Mortar Setting Bed and to bring finished surfaces within indicated tolerances. Set each Veneer Unit in a single operation prior to initial set of Mortar Setting Bed; do not return to areas already set and disturb Units for purposes of realigning finished surfaces or adjusting joints.
- H. Spaced Joint Widths:
 - 1. Provide nominal joint width of 3/8 inch with variations not exceeding plus or minus 1/16 inch.
 - 2. Provide nominal joint width indicated with variations not exceeding plus or minus 1/8 inch.

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- I. Grouting: Thoroughly blend the Grouting materials per the manufacturer's latest printed instructions. Grout joints as soon as possible after initial set of Mortar Setting Bed. Force Grout into joints, taking care not to smear Grout on adjoining Veneer Units and other surfaces. After initial set of Grout, finish joints by tooling to produce a slightly concave polished joint, free from drying cracks.
 - J. Cure Grout by maintaining in a damp condition per the manufacturer's latest printed instructions.

3.6 REPAIR, POINTING, CLEANING, AND PROTECTION

- A. Remove and replace Unit Paving Veneer that are loose, chipped, broken, stained, or otherwise damaged or if Units do not match adjoining Units as intended. Provide new Units to match adjoining Units and install in same manner as original Units, with same joint treatment to eliminate evidence of replacement.
- B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with mortar or grout. Point-up joints at sealant joints to provide a neat, uniform appearance, properly prepared for application of sealant.
- C. Cleaning: Remove excess grout from exposed finished Unit Paving Veneer surfaces; wash and scrub clean.
 - 1. Where evident, remove protective coating as recommended by protective coating manufacturer and acceptable to brick and grout manufacturer. Trap and remove coating to prevent it from clogging drains.
- D. Protection: Provide final protection and maintain conditions in a manner acceptable to Installer that ensures that Unit Paving Veneer installation is without damage or deterioration at the time of Substantial Completion.

3.7 APPLICATION OF SEALER

- A. Apply Sealer per Manufacturer's written instructions for surface preparation, application, and cleaning.

END OF SECTION 321413

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. Removal, salvage, storage and reinstallation of existing pavers.
- 2. Solid concrete pavers with openings between pavers filled with aggregate.
- 3. Aggregate setting bed for pavers.

B. Related Requirements:

- 1. Section 015639 "Temporary Tree and Plant Protection".
- 2. Section 024113 "Selective Site Demolition".
- 3. Section 024116 "Structural Demolition".
- 4. Section 024296 "Historic Removal and Dismantling."

1.3 ACTION SUBMITTALS

- A. Project Data: For removal, salvage techniques and storage.
- B. Shop Drawings: Record drawing showing extent of removals to scale and dimensioned.
- C. Graded inventory of salvaged pavers.
- D. Product Data: For the following:
 - 1. Replacement and supplemental Pavers.
- E. Sieve Analyses: For aggregate materials, according to ASTM C 136.
- F. Samples:
 - 1. Full-size units of each type of unit paver indicated.
 - 2. Aggregate fill.
 - 3. Aggregate setting bed materials.

1.4 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

1.5 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store salvaged and new pavers 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.
- B. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

PART 2 - PRODUCTS

2.1 CONCRETE UNIT PAVERS

- A. Source Limitations: Obtain each type of paver from single source that has resources to provide materials and products of consistent quality in appearance and physical properties.
 - 1. Reinstall salvaged and stockpiled existing pavers.
 - 2. New and replacement paver shall be a close match to the existing pavers.
- B. Solid Concrete Pavers for Porous Paving: Solid interlocking paving units of shapes that provide openings between units, complying with ASTM C 936/C 936M, and made from normal-weight aggregates.

2.2 AGGREGATE SETTING-BED MATERIALS

- A. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33/C 33M for fine aggregate.
- B. Soil Mix for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33/C 33M for fine aggregate blended with site soil.
- C. Aggregate Fill for Porous Paving: Graded, sound, crushed stone or gravel complying with ASTM D 448 for Size No. 8.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Proof-roll prepared subgrade according to requirements in Section 312000 "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with porous paver installation only after deficient subgrades have been corrected and are ready to receive sand leveling course for porous paving.

3.2 SALVAGE

- A. Remove existing pavers with techniques that will minimize damage during removal. Grade and sort pavers by quality and palatize separately into three categories:
1. Grade 1: Minimal chips or other damage and suitable for reinstallation.
 2. Grade 2: Chipped and scarred pavers but suitable for reinstallation.
 3. Grade 3: Cut or cracked pavers that could be suitable for reinstallation.
 4. Grade 4: Unsuitable for reinstallation.
- B. Submit summary and inventory of salvage materials to the Landscape Architect for review. Stage materials for review.

3.3 INSTALLATION, GENERAL

- A. Reinstall salvaged pavers to mimic or match existing installation. Install pavers to obscure any chips of other defects as possible. Do not cut to fit. Utilize previously cut pavers.
- B. Do not install new replacement unit pavers with chips, cracks, voids, discolorations, and other defects that might be structurally unsound or visible in finished work.
- C. Cut new unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
- D. Tolerances:
1. Variation in Plane between Adjacent Units (Lipping): Do not exceed 1/16-inch (1.5-mm) unit-to-unit offset from flush.
 2. Variation from Level or Indicated Slope: Do not exceed 1/8 inch in 24 inches (3 mm in 600 mm) and 1/4 inch in 10 feet (6 mm in 3 m) or a maximum of 1/2 inch (13 mm).
- E. Provide edge restraints as needed. Edge restraints are assumed to be existing.
1. Notify the Landscape Architect if edge restraints need to be added.

3.4 SETTING-BED INSTALLATION

- A. Compact subgrade uniformly to at least **95** percent of **ASTM D 698** laboratory density.
- B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- C. Place leveling course, and screed to a thickness of **1 to 1-1/2 inches** taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.

3.5 PAVER INSTALLATION

- A. Set unit pavers on leveling course, being careful not to disturb leveling base. If pavers have lugs or spacer bars to control spacing, place pavers hand tight against lugs or spacer bars. If pavers do not have lugs or spacer bars, place pavers with a 1/16-inch- (1.6-mm-) minimum and 1/8-inch- (3.2-mm-) maximum joint width. Use string lines to keep straight lines. Fill gaps between units that exceed **3/8 inch (10 mm)** with pieces cut to fit from full-size pavers. Cut pavers shall not be less than 1/3 of the of a full paver module.
 - 1. When installation is performed with mechanical equipment, use only unit pavers with lugs or spacer bars on sides of each unit.
- B. Compact pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf (16- to 22-kN) compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.
 - 1. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches (900 mm) of uncompacted pavers adjacent to temporary edges.
 - 2. Before ending each day's work, compact installed concrete pavers except for 36-inch (900-mm) width of uncompacted pavers adjacent to temporary edges (laying faces).
 - 3. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches (90 mm) of laying face.
 - 4. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.
- C. Place graded aggregate fill immediately after vibrating pavers into leveling course. Spread and screed aggregate fill level with tops of pavers.
 - 1. Before ending each day's work, place aggregate fill in installed porous paving except for 42-inch (1067-mm) width of unfilled paving adjacent to temporary edges (laying faces).
 - 2. As work progresses to perimeter of installation, place aggregate fill in installed paving that is adjacent to permanent edges unless it is within 42 inches (1067 mm) of laying face.
 - 3. Before ending each day's work and when rain interrupts work, cover paving that has not been filled with nonstaining plastic sheets to protect it from rain.

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- D. As work progresses, remove and replace pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

END OF SECTION 321443

SECTION 321500 – AGGREGATE SURFACING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes materials, labor, apparatus, tools, equipment, temporary construction, transportation, and services necessary for and incidental to performing the proper completion of Work, as required to make a complete exterior Aggregate Surfacing installation, as shown in the Contract Drawings, and as specified herein this Section.
- B. Work under this Section consists of, but is not necessarily limited to, furnishing and installing the following:
 - 1. Aggregate Surfacing Materials (Aggregates and Cobbles.).
- C. Related Sections: The following Sections contain requirements that relate to Work in this Section:
 - 1. Section 071700 – Bentonite Waterproofing, for membrane below cobbles in water features.
 - 2. Section 312219 – Fine Grading.
 - 3. Section 329113 – Soil Preparation.
 - 4. Section 329300 – Plants.

1.2 DEFINITIONS AND APPLICABLE STANDARDS

- A. References:
 - 1. ASTM – American Society for Testing and Materials.
 - 2. ANSI – American National Standards Institute.
- B. Definitions:
 - 1. psi – pounds per square inch (measurement).
 - 2. cu/ft – cubic-feet/foot (measurement).
 - 3. oc – on-center (measurement).

1.3 SUBMITTALS

- A. General: Submit each item in this Article in four (4) bound Submittal Booklets, and four (4) sets of Material Samples for review by the Landscape Architect.
- B. Submittal Booklets: Each Submittal Booklet under this Section shall be tabbed into specific sections, containing clearly identified and legible (through yellow highlighter or other specific identification methods) information indicated herein this Article.
- C. Product/Material Data. Submit available product/material literature (including color charts) supplied by manufacturer's, indicating that their products comply with specified requirements. Provide manufacturing source (name, address, and telephone number), and distributor source (name, address, and telephone number) for each type of product/material.

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- D. Material Samples: For each type of material specified herein, provide Material Samples for review by the Landscape Architect. Include the full range of exposed color and texture expected in the completed Work. Provide Material Samples bound and individually wrapped in re-sealable labeled plastic bags (as applicable):
 - 1. 0.50 cu/ft of Aggregate Surfacing Material (i.e. Aggregates and Cobbles) for each color and texture of material required for Project.
 - 2. One (1) two-foot (2'-0") square sample of Weed Control Barrier/Geotextile Filter Fabric.
 - E. Scaled Shop Drawings: Not Required.
 - F. Field-Constructed Mock-ups: Not Required.
 - G. Qualification Data: Submit names for firms and persons specified in the "Quality Assurance and Control" Article to demonstrate their capabilities and experience on similar Landscape Planting Accessories installations.
 - H. Submittals under this Article will be rejected and returned without the benefit of review by the Landscape Architect if they are difficult to read due to insufficient scale, poor image quality, or poor drafting quality; or if all of the required information is missing or not presented in the format as requested. Partial Submittals will not be accepted.
 - I. No Work shall proceed under this Section until Submittal requirements indicated herein have been reviewed accordingly by the Landscape Architect.

1.4 QUALITY ASSURANCE AND CONTROL

- A. Installer Qualifications:
 - 1. Requirement: Valid **Texas** (General Contractor) License.
 - 2. Engage an experienced Installer who has completed Aggregate Surfacing work similar in material, design, and extent to that indicated for this Project and with a record of successful installation.
 - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on the Project site during times that installations under this Section are in progress.
- B. Observation: Landscape Architect may observe installation of Aggregate Surfacing at Project Site for compliance with requirements for type, size, and quality. Landscape Architect retains right to observe Aggregate Surfacing for defects and to reject unsatisfactory or defective material at any time during progress of Work. Contractor shall remove rejected Aggregate Surfacing immediately from Project site.
- C. Permits, Fees, Bonds, and Inspections: Contractor shall arrange and pay for permits, fees, bonds, testing services, and inspections necessary to perform and complete Work under this Section.
- D. Single-Source Responsibility: Obtain each color, type, and variety of products/materials from a single source with resources to provide products/materials of consistent quality in appearance and physical properties without delaying Work.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Provide new, unused materials indicated under this Section. Store and secure properly to prevent theft or damage. Deliver and store perishable material in original, unopened packaging.

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- B. Damaged Materials: Be responsible for all damage or disfiguration of Work until Final Acceptance. Remove off site and replace at no additional cost to Owner all damaged or rejected materials.
 - C. Deliver materials so as to not delay Work, and install only after preparations for installation have been completed.

1.6 COORDINATION, SCHEDULING, AND OBSERVATIONS

- A. Utilities: Determine location of above grade and underground utilities and perform Work in a manner which will avoid damage to utilities. Hand excavate, as required. Maintain grade stakes until removal is mutually agreed upon by parties concerned.
- B. Excavation: When conditions detrimental to installing Aggregate Surfacing are encountered, such as adverse drainage conditions or obstructions, cease installation operations and notify Landscape Architect for further direction.
- C. Field Measurements: Contractor shall take field measurements as required. Report major discrepancies between the Contract Drawings and field dimensions to the Landscape Architect prior to commencing Work.
- D. Installation: Perform installation of Aggregate Surfacing only when weather and soil conditions are suitable in accordance with locally accepted practices.
- E. Construction Site Observations: Periodic site observations shall be made by the Landscape Architect during the installation of Work under this Section for compliance with requirements for type, size, and quality. Landscape Architect retains right to observe Work for defects and to reject unsatisfactory or defective material at any time during progress of Work. Contractor shall remove rejected materials immediately from Project site. The Contractor shall request, in writing, at least one (1) week in advance of the time when mandatory site observation(s) by the Landscape Architect are required.

1.7 SUBSTITUTIONS

- A. Consideration: Materials to be considered equal to the Materials indicated herein this Section shall be reviewed by the Landscape Architect. Materials with equal performance characteristics produced by other Manufacturer's and/or Distributors may be considered, providing deviations in dimensional size, color, composition, operation, and/or other characteristics do not change the design concept, aesthetic appearance, nor intended performance, as solely judged by the Landscape Architect. The burden of proof on product equality is on the Contractor.
- B. Specific reference to Manufacturer's names and products specified herein are used as standards of quality. This implies no right to the Contractor to substitute other materials without prior written approval by the Landscape Architect for Work under this Section.
- C. Materials substituted and installed by the Contractor, without prior written approval by the Landscape Architect, will be rejected. Contractor shall not be entitled to be compensated by the Owner where the Contractor has installed rejected substitutions without receiving prior written approval.
- D. Contract Price: Substituted Materials under this Section shall not increase the Contract price.

PART 2 - PRODUCTS

2.1 AGGREGATE MATERIALS

A. Aggregate Infill Material:

1. General: Hard, durable aggregates, washed free of loam, sand, clay, and other foreign substances or debris.
2. Quantity: Provide and install in quantity required to provide acceptable depth and coverage as indicated on the Contract Drawings.
 - a. Provide an adequate amount of Aggregate Surfacing material between Cobble voids, as applicable.
3. Material: Match approved referee sample, as acquired by the Landscape Architect, to compare for material, color, texture, size, and other characteristics relating to aesthetic effects.
 - a. Type: **Crushed Limestone**.
 - b. Size: ½ inch – 1 inch.
 - c. Products & Manufacturer's: Subject to compliance with requirements, provide products by the following:
 - 1) **Texas Soil and Stone, (210) 497-1777, texasoilandstone.com**.
 - 2) or equal, as approved by the Landscape Architect.

B. Cobbles:

1. General: Cobbles shall be relatively smooth in texture, with a rounded appearance, and in random shades of colors typical of native cobbles found along the bottom of rivers and streams. Cobbles shall be clean and free from soil, debris, and markings. Cobbles that are broken, split, or with angular or sharp edges, are not acceptable.
2. Quantity: Provide and install in quantity required to provide acceptable depth and coverage as indicated on the Contract Drawings.
 - a. Provide an adequate amount of Aggregate Infill Surfacing material between Cobble voids, as indicated herein this Article.
3. Material: Match approved referee sample, as acquired by the Landscape Architect, to compare for material, color, texture, size, and other characteristics relating to aesthetic effects.
 - a. Type: **Limestone**
 - b. Size: **3 inch – 5 inch**.
 - c. Products & Manufacturer's: Subject to compliance with requirements, provide products by the following:
 - 1) **Texas Soil and Stone, (210) 497-1777, texasoilandstone.com**.
 - 2) or equal, as approved by the Landscape Architect.

PART 3 - EXECUTION

3.1 GENERAL

- A. Installation practices of the Aggregate Surfacing shall be performed during those periods when weather and soil conditions are suitable and in accordance with locally accepted horticultural practice, as approved by the Landscape Architect. Contractor shall notify the Landscape Architect, in writing, on the anticipated commencement date and length of duration of the landscape installation.

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- B. Examination: Examine areas to receive landscaping for compliance with requirements and for conditions affecting performance of Work of this Section. NO WORK UNDER THIS SECTION SHALL COMMENCE UNTIL ALL SUBMITTALS UNDER THIS SECTION HAVE BEEN REVIEWED AND APPROVED, IN WRITING. DO NOT PROCEED WITH INSTALLATION UNTIL UNSATISFACTORY CONDITIONS HAVE BEEN CORRECTED.
 - C. Prior to Work in this Section, Contractor shall examine previously installed Work from other trades and verify that such Work is complete and as required, to the point where the installation of the Landscape Planting Accessories may commence properly.

3.2 PROTECTION OF SITE

- A. Contractor shall protect existing and new improvements and systems and clay membranes installed prior to installation of Aggregate Surfacing. Maintain protection in place until completion of Work and Landscape Establishment Period.

3.3 INSTALLATION OF AGGREGATE SURFACING MATERIALS

- A. General: Backfill surfaces of pits, trenches, planted areas, and other areas indicated to appropriate finished grades.
- B. Aggregate Infill:
 - 1. Aggregate Infill consists of loose aggregate material to fill voids between cobbles a below the finish elevation on the cobble surfacing.
 - a. Spread Aggregate Infill evenly throughout all areas designated to receive the Cobbles at the following thickness and rates:
 - 1) Thickness: 3 inches.
 - 2. Protect Bentonite Clay liner during installation of Aggregate Surfacing.
 - 3. Protect Plant Materials during installation of Aggregate Surfacing; do not place Aggregate Surfacing against the trunks or stems of plants. Remove Aggregate Surfacing that is placed against the growing bases or within the basal nodes of the plants.
 - 4. Plant Materials that are damaged during this operation, at the sole opinion of the Landscape Architect, shall be replaced accordingly at the Contractor's expense.
 - 5. Replace Aggregate Infill that is unlike in character (color, size, texture). Defective, fractured, stained, or material which does not meet the requirements herein in this Section shall be removed and replaced with appropriate Aggregate Surfacing material as specified.
- C. Cobbles:
 - 1. General: Verify locations to receive Cobbles.
 - 2. Protect Bentonite Clay liner during installation of Aggregate Surfacing.
 - 3. Install Cobbles after sub-grade elevation has been established and compacted accordingly. Hand-place Cobbles with an even, dense, but random distribution of Cobbles (size, color, etc.). Set Cobbles at the required depth to adequately mask the sub-grade, following lines and levels to present a "natural" or "organic" composition. Set Cobbles accordingly to minimize large gaps or voids between the Cobbles.
 - 4. After placement of the Cobbles, seed crushed limestone infill material and compact accordingly between the Cobbles to further mask the sub-grade and complete the composition.

3.4 CLEAN UP AND PROTECTION

- A. For Work under this Section, keep Work area in a clean, orderly, and safe condition. Contractor shall remove trash caused from his Work on a weekly basis throughout the duration of the Work.
- B. Protect landscaping from damage due to landscape operations, operations by other Contractors and trades, and trespassers. Maintain protection during installation and Landscape Establishment Period. Treat, repair, or replace damaged Aggregate Surfacing as directed.
- C. Upon completion of his Work under this Section, the Contractor shall remove rubbish, waste, debris, excess construction materials, and other items resulting from construction operations offsite as described herein this Section and directed by the Landscape Architect.

3.5 FINAL REVIEW

- A. Final Review under this Section shall be performed upon completion of the Landscape Establishment Period. (Refer to Section 329813 – Landscape Establishment Period for requirements).

END OF SECTION 321500 – AGGREGATE SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes parking striping, handicapped stall graphics, drive lane markings, and related work as shown and detailed on the Drawings.

1.3 REFERENCES

- A. AASHTO: American Association of State Highway and Transportation Officials.
1. AASHTO M 247 – Standard Specification for Glass Beads Used in Pavement Markings.
 2. AASHTO M 249 – Standard Specification for White and Yellow Reflective Thermoplastic Striping Material (Solid Form).
- B. Texas Department of Transportation. Department of Transportation (TxDOT), 125 East 11th Street, Austin, Texas 78701.
1. TxDOT DMS-8200 – Traffic Paint
 2. TxDOT DMS-8220 – Hot Applied Thermoplastic.

1.4 SUBMITTALS

- A. Submit product data; include surface preparation, product handling and application requirements.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Submit application equipment list appropriate for the material(s) to be used. Include manufacturer's descriptive data and certification for the planned use that indicates area of coverage per pass, pressure adjustment range, tank and flow capacities, and all safety precautions required for operating and maintaining the equipment. Provide and maintain machines, tools, and equipment used in the performance of the work in satisfactory operating condition, or remove them from the work site. Provide mobile and maneuverable application equipment to the extent that straight lines can be followed and normal curves can be made in a true arc.

2.2 MATERIALS

- A. Marking Paint:
1. Chlorinated rubber federally approved traffic paint applied with two coats at the manufacturer's recommended rate (total minimum rate of 100 to 110 sq. ft/gal). Stripes shall match color and parking/drive layouts that currently exist.
 2. Acrylic traffic paint shall conform to the requirements of TxDOT Material Specification DMS-8200, Traffic Paint, and be applied at manufacturer recommended rates.
 3. Provide "White" paint to mark paving stalls, directional arrows, etc. for asphalt paving areas. Provide "Yellow" paint to mark paving stalls, directional arrows, etc. for concrete paving areas. Provide "Blue" color for handicapped marking, and "Red" for fire lanes, unless otherwise indicated. Provide white stenciled "No Parking - Fire Lane" marking as applicable.
- B. Thermoplastic Compound
1. Thermoplastic to conform to the requirements of AASHTO M 249 and TxDOT DMS-8220.
 2. Asphalt Concrete Primer: Provide thermosetting adhesive primer with a solids content of pigment reinforced synthetic rubber and synthetic plastic resin dissolved or dispersed in a volatile organic solvent for asphaltic concrete pavements. The solids content must not be less

than 10 percent by weight at 70 degrees F and 60 percent relative humidity. A wet film thickness of 0.005 inch, plus or minus 0.001 inch, must dry to a tack-free condition in less than 5 minutes.

3. Portland Cement Concrete Primer: Provide an epoxy resin primer for portland cement concrete pavements, of the type recommended by the manufacturer of the thermoplastic composition.
- C. Glass Traffic Beads
 1. Provide glass traffic beads meeting the requirements of AASHTO M 247, Type I.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which work is to be performed and notify Owner's Representative of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Testing for Moisture:
 1. Test the pavement surface for moisture before beginning pavement marking after each period of rainfall, fog, high humidity, or cleaning, or when the ambient temperature has fallen below the dew point. Do not commence marking until the pavement is sufficiently dry and the pavement condition has been approved by the Owner's Designated Representative.
 2. Employ the "plastic wrap method" to test the pavement for moisture as follows: Cover the pavement with a 12 inch by 12 inch section of clear plastic wrap and seal the edges with tape. After 15 minutes, examine the plastic wrap for any visible moisture accumulation inside the plastic. Do not begin marking operations until the test can be performed with no visible moisture accumulation inside the plastic wrap. Re-test surfaces when work has been stopped due to rain.

3.2 PREPARATION

- A. Confirm that asphalt and concrete paving has cured a minimum of 30 days and that pavement surfaces are dry before starting pavement marking.
- B. Surface Preparation:
 1. Thoroughly clean surfaces to be marked before application of the paint. Remove dust, dirt and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water or a combination of these methods as required.
 2. Remove grease and oil deposits with solvents and detergents.
 3. Remove latence and curing compound from all new Portland cement concrete surfaces.
- C. Early Painting of Asphalt Pavements
 1. For asphalt pavement systems requiring painting application at less than 30 days, apply the paint and beads at half the normal application rate, followed by a second application at the normal rate after 30 days.
- D. Early Painting of Portland Cement Concrete Pavements
 1. Pretreat rigid pavements that require early painting with an aqueous solution containing 3 percent phosphoric acid and 2 percent zinc chloride. Apply the solution to the areas to be marked,
- E. Carefully and accurately lay out the location and termination of traffic and lane markings at the locations indicated. Protect adjacent curbs, walks, fences, and other items from receiving paint.
- F. Pavement marking paint shall not be applied until layout, colors, and placement have been verified with the Owner.

3.3 APPLICATION

- A. Paint
 1. Striping: Apply paint with mechanical equipment to produce stripes with uniform straight edges, minimum 4" wide. Apply in 2 coats at manufacturers recommended rates to provide a 15-mil minimum wet film thickness.

- B. Thermoplastic Compound
 1. Place thermoplastic pavement markings, free from dirt or tint, upon dry pavement. The temperature must be a minimum of 40 degrees F and rising at the time of installation. Apply all centerline, skipline, edgeline, and other longitudinal type markings with a mobile applicator. Place all special markings, crosswalks, stop bars, legends, arrows, and similar patterns with a portable applicator, using the extrusion method.
 2. Primer: After surface preparation has been completed, prime the asphalt or concrete pavement surface with spray equipment. Allow primer materials to "set-up" prior to applying the thermoplastic composition.
 3. After the primer has "set-up", apply the thermoplastic at temperatures specified by the material manufacturer at the point of deposition. Apply all extruded thermoplastic markings at the specified width and at a thickness of not less than 0.125 inch 0.190 inch. Apply all sprayed thermoplastic markings at the specified width and the thickness designated in the contract plans. If the plans do not specify a thickness, apply centerline markings at a wet thickness of 0.090 inch, plus or minus 0.005 inch, and edgeline markings at a wet thickness of 0.060 inch, plus or minus 0.005 inch.
 4. Extrude or spray thermoplastic reflectorized pavement marking compound in a molten state onto a primed pavement surface. Following a surface application of glass beads and upon cooling to normal pavement temperatures, the marking must be an adherent reflectorized strip of the specified thickness and width that is capable of resisting deformation by traffic.
- C. Reflective Media
 1. Immediately after installation of the thermoplastic material, mechanically apply drop-on reflective glass spheres at the rate of:
 - a. 200 pounds of drop on glass spheres per ton of applied thermoplastic when the thermoplastic is being applied at 0.090 inch film thickness.
 - b. 150 pounds of drop on glass spheres per ton of applied thermoplastic when the thermoplastic is being applied at 0.125 inch film thickness.
 2. To enable the spheres to embed themselves into the hot thermoplastic, the sphere dispenser shall be positioned immediately behind the thermoplastic application device to ensure that the spheres are applied to the thermoplastic material while it is still in the molten state.

3.4 CURING AND PROTECTION

- A. Curing and Protection: Barricade pavement areas to prevent traffic until coatings are completely cured and ready to receive traffic in accordance with coating manufactures printed instructions and recommendations.

END OF SECTION

SECTION 323400 – FABRICATED BRIDGES

PART 1 GENERAL

1.1 SUMMARY

- A. These specifications are for a fully engineered clear span custom bridges of welded steel construction and shall be regarded as minimum standards for design, fabrication and construction.
1. Project specific design calculations.
 2. Project specific shop drawings.
 3. Splicing and erection procedures.
 4. Warranty information.
 5. Inspection and Maintenance procedures.
 6. Miscellaneous embeds for bridge abutments.

1.2 RELATED WORK

- A. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
1. Section 031000, CONCRETE FORMING AND ACCESSORIES.
 2. Section 032000, CONCRETE REINFORCEMENT.
 3. Section 033000, CAST-IN-PLACE CONCRETE, for Abutments.
 4. Section 101400, EXTERIOR SIGNAGE.
 5. Division 26, Electrical for Lighting at the Pedestrian Arch Bridge.
 6. Section 265600, EXTERIOR LIGHTING.
 7. Section 310000, SITE EARTHWORK.
 8. Section 315000, EXCAVATION SUPPORT AND PROTECTION.
 9. Section 321316, DECORATIVE CONCRETE PAVING, for Bridge Deck.

1.3 REFERENCES

- A. Comply with applicable requirements of following standards. Where these standards conflict with other specified requirements, the most restrictive requirement shall govern.
1. International Building Code (IBC) 2024.
 2. American Association of State Highways and Transportation Officials (AASHTO).

LRFD Bridge Design Specifications, Bridge Construction, latest edition.
LRFD Bridge Design Specifications, Steel Bridge Design, latest edition.
LRFD Bridge Design Specifications, Steel Bridge Fabrication, latest edition.
 3. American Institute of Steel Construction (AISC):

Code Code of Standard Practice for Steel Buildings and Bridges.

Specification Specification for the Design, Fabrication and Erection of
Structural Steel for Buildings.

4. American Society for Testing and Materials (ASTM):

A 36	Structural Steel
A 47	Ferritic Malleable Iron Castings
A 48	Gray Iron Castings
A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
A 123	Zinc (Hot-Galvanized) Coatings on Products Fabricated from
	Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
A 153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A 167	Stainless and Heat Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
A 307	Carbon Steel Externally Threaded Standard Fasteners
A 325	High Strength Bolts for Structural Steel Joints
A 366	Steel, Carbon, Cold-Rolled sheet, Commercial Quality
A 385	High-Quality Zinc Coatings (Hot-Dip)
A 386	Zinc Coating (Hot-Dip) on Assembled Steel Products
A 446	Steel Sheet, Zinc-Coated (Galvanized) by the Hot- Dip Process, Structural (Physical) Quality
A 500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
A 572	High Strength Structural Steel
A 671	ASTM A-761 Corrugated Steel Structural Plate, Zinc Coated for Field-Bolted Pipe, Pipe-Arches and Arches
A 992	Structural Steel Alloy Wide Flange and I Beams

5. American Welding Society (AWS):

D1.1	Structural Welding Code--Steel.
D1.3	Structural Welding Code--Sheet Steel
D1.5	Structural Welding Code—Bridge Welding Code
D1.6	Structural Welding Code--Stainless Steel

6. Corps of Engineers (CE):

CRD-C-621	Specification for Nonshrink Grout
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7. American Association of State Highway and Transportation Officials (AASHTO):

LRFD Guide Specifications for the Design of Pedestrian Bridges, 2009
LRFD Bridge Design Specifications, 9th edition, 2020
LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, latest edition
Guide Specifications for LRFD Seismic Bridge Design, latest edition

M 133 Standard Specification for Preservatives and Pressure Treatment Processes for Timber, latest edition

8. Steel Deck Institute (SDI):

C-2017 Standard for Composite Steel Floor Deck-Slabs

9. Research Council on Structural Connections (RCSC):

Specifications for Structural Joints using F3125 or F3125M High Strength Structural Bolts.

1.4 DEFINITIONS

- A. Owner - In these specifications the word "Owner" shall mean City of San Antonio.
- B. Manufacturer - In these specifications the word "Manufacturer" shall mean Bridge Brothers.
- C. Contractor - In these specifications the word "Contractor" shall mean the firm or corporation undertaking the execution of any work under the terms of these specifications.

1.5 BID SUBMITTALS

- A. Bid Submittal for Bridge Fabricator and Supplier Qualifications: Submit items described under Quality Assurance and here in this section. Suppliers other than those listed in this section may be used provided the engineer or owner's agent evaluates the proposed supplier and approves the supplier fourteen (14) days prior to the bid submission deadline. The contractor must provide the following documentation, for any proposed supplier who is not listed under Section 2 for approval. The documentation to ensure the proposed substitution will be in compliance with these specifications shall include:
 - 1. Product Literature.
 - 2. Reference Projects.
 - 3. Project specific representative drawings for bridge projects listed above with material and design code references.
 - 4. AISC Shop Certification within the past 12 months.
 - 5. Welder Qualifications.
 - 6. AWS Certified Fabricator Certification within the past 12 months.
 - 7. State Specific Registration Certification of the Professional.
 - 8. Engineer who will be performing the design of the bridge.
 - 9. Quality Assurance Procedures.
 - 10. The name and qualifications of the Technical Assistant that will conduct on-site assistance during field installation of the structure until secure and stable.
 - 11. Bridge Design Engineer shall produce a certificate of insurance demonstrating Professional Liability Errors and Omissions coverage of \$10M or greater.
 - 12. Warranty Information.
 - 13. Inspection Procedures.
- a. The owner's agent or Landscape Architect of Record will evaluate and verify the accuracy of the submittal prior to bid. If the owner's agent determines that the qualifying criteria have not been met the contractor's proposed supplier shall be rejected. This ruling shall be final.

Alternative suppliers not pre-approved prior to bid will not be allowed after the bid opening.

1.6 SUBMITTALS

- A. General: Submit each item in this section in four (4) bound Submittal Packages and provide four (4) sets of Material Samples for review by the Landscape Architect.
- B. Submittal Package: Each Submittal under this Section shall be tabbed into specific sections, containing clearly identified (through yellow highlighter or other specific identification methods) and legible information on the following information indicated in this Article.
- C. Product Data: Submit manufacturer's printed product data, specifications, standard details, installation instructions, use limitations and recommendations for each material used. Provide certifications that materials and systems comply with specified requirements.
- D. Shop Drawings: Provide large scale shop drawings for fabrication, installation and erection of all parts of the work including adjacencies. Provide plans, elevations, and details of anchorages, connections and accessory items. Provide installation templates for work installed by others. Show all interfaces and relationships to work of other trades. Shop drawings shall be unique drawings, prepared to illustrate the specific portion of the bridge(s) being fabricated. All relative design information such as member size, material specification, bridge reactions, dimensions, general notes, and required critical welds shall be clearly shown on the drawings. Drawings shall have cross referenced details and sheet numbers. All drawings shall be signed and sealed by a Professional Engineer registered in the state of Texas. A stamped electronic copy shall be provided in PDF format.
 - 1. Engineering: Provide signed and stamped drawings prepared by a professional engineer, registered in the State of Texas, to certify that work of this Section meets or exceeds performance requirements specified.
 - 2. All Relevant Bridge Dimensions.
 - 3. Bridge Cross sections.
 - 4. Sufficient Detailing.
 - 5. Member Cross sections.
 - 6. General Notes indicating material specifications.
 - 7. Weld Details.
 - 8. Detail of Bolted Splices (if applicable).
 - 9. Signature and Seal of PE licensed in accordance with this specification.
 - 10. Camber Details.
- E. Structural Calculations: Structural Calculations for the bridge superstructure shall be submitted by the bridge manufacturer. All calculations shall be signed and sealed by a Professional Engineer licensed within the project state. The calculations shall include all design information necessary to determine the structural adequacy of the bridge. A stamped electronic copy shall be provided in PDF format. The following criteria must be included for approval.
 - 1. Applied loads and conditions for all load combinations.
 - 2. All resistance checks for axial, bending, and shear in each critical member type (i.e. top chord, bottom chord, vertical, floor beam, etc.).
 - 3. Truss and Floor Deflection Checks.
 - 4. FEA Boundary Conditions.

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5. FEA Data Input.
 6. FEA Results and Supplementary Calculations for all Stress & Deflection Analyses.
 7. FEA Results for Frequency Analysis.
 8. U-Frame Stiffness Checks.
 9. Bolted Splice Connections (if applicable).
 10. Bearing Plate Analysis.
 11. Critical weld connection check for each truss member type (i.e. vertical, diagonal).
 12. Welded Tubular Connections (see section 4.3.4 of this document for design check requirements)
 13. Bridge Reactions.
 14. Expansion and Contraction Requirements and/or Induced Loads.
- F. Field Measurements: Take all necessary field measurements before preparation of shop drawings and fabrication. Do not delay progress of the job. If field measurements are not possible prior to fabrication, allow for field cutting and fitting.
- G. Initial Selection Samples: Submit samples showing complete range of colors, textures, and finishes available for each shop finished material used.
- H. Verification Samples: Submit representative samples of each shop finished material that is to be exposed in the completed work. Show full color ranges and finish variations expected. Provide samples having minimum size of one hundred forty-four (144) square inches.
1. Include samples of welded connections.
- I. Welders Certification: Provide certifications, signed by Contractor, certifying that welders employed at project comply with requirements specified under AWS D1.1, AWS D1.3 and AWS D1.6 within the past 12 months.
- J. Submittals under this Section will be rejected without the benefit of review by the Landscape Architect if they are difficult to read due to insufficient scale, poor image quality, or poor drafting quality; or if the required information is missing or not presented in the format as requested.
- K. No Work shall proceed under this Section until Submittal requirements indicated herein have been reviewed accordingly by the Landscape Architect and project team.
- 1.7 GENERAL REQUIREMENTS
- A. Prior to bidding the work, the Contractor shall examine, investigate and inspect the construction site as to the nature and location of the work, and the general and local conditions at the construction site, including without limitation, the character of surface or subsurface conditions and obstacles to be encountered on and around the construction site and shall make such additional investigation as he may deem necessary for the planning and proper execution of the work.
- B. The Contractor shall furnish all labor, material and equipment and perform all work and services except those set out and furnished by the Owner, necessary to complete in a satisfactory manner the site preparation, excavation, filling, compaction, grading as shown on the plans and as described therein. This work shall consist of all mobilization clearing and grading, grubbing, stripping, removal of existing material unless otherwise stated, preparation of the land to be filled, filling of the land, spreading and compaction of the fill, and all subsidiary work necessary to complete the grading of the cut and fill areas

to conform with the lines, grades, slopes, and specifications. This work is to be accomplished under the observation of the Owner or his designated representative.

- C. The Contractor shall verify all measurements and shall take all field measurements necessary before fabrication. Welding to or on structural steel shall be in accordance with AWS D1.1/D1.1M. Items specified to be galvanized, when practicable and not indicated otherwise, shall be hot-dip galvanized after fabrication. Galvanizing shall be in accordance with ASTM A 123/A 123M, ASTM A 653/A 653M, or ASTM A 924/A 924M, as applicable. Exposed fastenings shall be compatible materials, shall generally match in color and finish, and shall harmonize with the material to which fastenings are applied. Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included. Poor matching of holes for fasteners shall be cause for rejection. Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall provide strength and stiffness. Joints exposed to the weather shall be formed to exclude water.

1.8 QUALITY ASSURANCE

- A. Engineering: Provide services of a professional engineer, registered in the State of Texas, to design and certify that work of this Section meets or exceeds performance requirements specified.
- B. Shop fabricate work to greatest extent possible. Label each piece in shop to facilitate field assembly.
- C. Installer Qualifications: Arrange for installation of bridges specified in this Section by the same firm that fabricated it. No brokers shall be permitted and all installation and coordination is to be performed by the fabricator.
- D. Fabricator Qualifications: A firm experienced in producing bridge fabrications similar to that indicated for this Project. Proposed suppliers must have at least ten (10) years' experience designing and fabricating this type of structure and a minimum of Ten (10) successful bridge projects, of similar style and construction as specifically written in these specifications and drawings, each of which has been in service at least three (3) years.
- E. Welding: Qualify procedures and personnel according to the following:
 - 1. All welding shall conform to the AASHTO/AWS D1.5 Bridge Welding Code with the exception of secondary members comprised of hollow structural sections. Hollow structural connection welding will comply with AWS D1.1. All welding utilizes E70 or E80 series electrodes.
- F. Manufacturers Shop Coordination: During fabrication submit digital images of the fabrication progress at key times in the process. Schedule and provide one (1) site visit to the manufacturer for review of the bridges with the Owner, Contractor and Landscape Architect as required to review the progress and workmanship during fitting testing and dry assembly.

1.9 DELIVERY, STORAGE AND HANDLING

- A. Bridges will be delivered by truck to a location nearest to the site accessible by roads. Hauling permits and freight charges are the responsibility of the manufacturer.

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- B. The manufacturer will notify the contractor in advance of the expected arrival. Information regarding delays after the trucks depart the plant such as weather, delays in permits, re-routing by public agencies or other circumstances will be passed on to the contractor as soon as possible.
 - C. The manufacturer will advise the contractor of the actual lifting weights, attachment points and all necessary information to install the bridge. Lifting procedure submittals shall be the responsibility of the bridge manufacturer.
 - D. Store bridge structures off of the ground and under cover. Protect from damage. Maintain shop applied coatings until installation is complete. Sequence deliveries to avoid delays, but minimize on-site storage.

1.10 PROJECT CONDITIONS

- A. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating bridge structure without field measurements. Coordinate wall, abutments, columns and other contiguous construction to ensure that actual dimensions correspond to established dimensions.

- 1. If practical, provide allowance for trimming and fitting at site.

1.11 COORDINATION

- A. Coordinate installation of anchorages for fabricated metal items. Furnish setting drawings, templates, and directions for installing anchorages, including items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.12 WARRANTY

- A. The Bridge Manufacturer shall warrant, at the time of delivery, that it has conveyed good title to its steel structure, free of liens and encumbrances created by the Bridge Manufacturer, and that its steel structure is free of defects in design, material, and workmanship. This warranty shall be valid for a period of one (1) year from Substantial Completion.
- B. Paint, galvanizing, and other special coatings, shall be warranted by the coating manufacturer in accordance with their warranty provisions.

PART 2 - PRODUCTS

2.1 QUALIFIED FABRICATOR

- A. Preapproved Manufacturer / Supplier: Bridge Brothers Inc, Atlanta GA (866) 258-3401 sales@bridgebrothersinc.com; Contact: Aaron Gentilucci; agentilucci@bridgebrothersinc.com.
- B. Each bidder is required to identify the intended bridge supplier listed as part of the bid submittal. Refer the Section 1.5 for Bid Submittal requirements.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design miscellaneous framing and supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Thermal Movements: Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. 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.
- C. Comply with applicable seismic code requirements and design suitable restraint and bracing as required. Refer to structural general notes for applicable criteria.

2.3 GENERAL DESIGN FEATURES

- A. Refer to the Landscape Architectural Drawings for bridge design, style and dimensions.
- B. Estimated Weights:
 - 1. Pedestrian Arch Bridge: 36,000 pounds.
 - 2. Pedestrian Girder Bridge: 16,000 pounds.
- C. Safety Rails: Horizontal safety rails shall be placed on the structure up to a minimum height of forty-two inches (42") above the deck surfaces. Safety rails shall be placed so as to prevent a four-inch (4") sphere from passing through the truss. Safety rails shall be welded to the inside or outside of the structure. Safety rails shall have their ends sealed and ground smooth so as to produce no sharp edges if safety rails are placed on the inside of the structure.
- D. Camber: The bridge shall have a vertical camber dimension at midspan equal to one hundred percent (100%) of the full dead load deflection.
- E. The bridge abutments shall be constructed at the elevation on both ends of the bridge or as required by the contract documents. Bridge shall have plumb verticals and flat base plates in all scenarios.

2.4 DESIGN LOADS

- A. Loads General: In considering design and fabrication issues, this structure shall be assumed to be statically loaded. No dynamic analysis shall be required nor shall fabrication issues typically considered for dynamically loaded structures be considered for this bridge.
- B. Dead Loads: The bridge structure shall be designed considering its own dead load (superstructure and original decking) only. No additional dead loading shall be considered.

- C. Pedestrian Live Loads:
1. Main supporting members, including girders, trusses and arches shall be designed for a pedestrian live load of one hundred pounds (100 lbs) per square foot of bridge walkway area. The pedestrian live load shall be applied to those areas of the walkway so as to produce maximum stress in the member being designed. Pedestrian live loads shall not be reduced.
 2. Secondary members such as bridge decks and supporting floor systems, including secondary stringers, floor beams, and their connections to main supporting members shall be designed for a live load of one hundred pounds (100 lbs) per square foot, with no reduction allowed.
- D. Vehicle Load: All the concentrated or wheel loads shall be placed so as to produce the maximum stress in each member being analyzed. Critical stresses shall be calculated assuming there is only one (1) vehicle on the bridge at any given time. Assumptions that vehicles only travel down the center of the bridge or that the vehicle load is a uniform line load shall not be allowed. Allow for an occasional eighteen hundred (1,800) pound four wheeled vehicle.
- E. Wind Load:
1. Horizontal Forces: The bridge shall be designed for a wind load as specified by AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges, latest edition. The wind load shall be applied horizontally at right angles to the longitudinal axis of the structure. The wind load shall be considered both in the design of the lateral load bracing system and in the design of the truss vertical members, floor beams, and their connections.
 2. Overturning Forces: The effect of forces tending to overturn structures shall be calculated assuming that the wind direction is at right angles to the longitudinal axis of the structure. In addition, an upward force shall be applied at the windward quarter point of the transverse superstructure width. This force shall be twenty pounds (20lbs) per square foot of deck.
- F. Safety Rails: The safety rail system shall be designed for loading of a two hundred pound (200 lbs) point load and fifty pounds per lineal foot (50plf) acting currently applied horizontally at right angles.
- G. Load Combinations: The loads listed herein shall be considered to act in the following combinations, whichever produce the most unfavorable effects on the bridge superstructure or structural member concerned. [DL = Dead Load, LL = Live Load, WL = Wind Load, VL = Vehicle Load].

Strength I

$$1.25*DL+1.75*LL$$

$$1.25*DL+1.75*VL$$

Strength III

$$1.25*DL+WL+OW$$

Service I

$$DL+LL+WL+OW$$

Fatigue I

$$\text{Fatigue WL Only}$$

1. The foundation engineer will determine any additional loads (i.e. earth pressure, stream force on abutments, wind loads other than those applied perpendicular to the long axis of the bridge, etc.) and load combinations required for design of the abutments.

- H. Frequency: Frequency analysis shall be completed to determine that the bridge frame is sufficient to avoid resonance due to frequencies likely encountered under normal use for the following load combinations and in accordance with section 6 of AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges, latest edition.

2.5 FERROUS METALS

- A. General: Provide products and materials of new stock, free from defects, and of best commercial quality for each intended purpose.
- B. Steel Plates, Shapes, and Bars: ASTM A 36.
- C. Steel Tubing: ASTM A 500 or A 501, hot or cold rolled, as required for design loading.
- D. Steel Pipe: ASTM A 53, schedule 40, Type S (seamless), black except where galvanized is indicated, Grade A for cold-bending.
- E. Steel Sheet: ASTM A 366, A 570, or A 611, grade required for design loading.
- F. Minimum Thickness of Metal: The minimum thickness of all main structural steel members shall be one-quarter of an inch (1/4") nominal and be in accordance with the AISC Manual of Steel Construction "Standard Mill Practice Guidelines". For ASTM A500 and ASTM A847 tubing, the section properties used for design shall be per the Steel Tube Institute of North America, Hollow Structural Sections, "Dimensions and Section Properties".

2.6 STAINLESS STEEL

- A. Castings: ASTM A 743/A 743M, Grade CF 8M or CF 3M.
- B. Sheet, Strip, Plate, and Flat Bar: ASTM A 666, Type 304.
- C. Bars and Shapes: ASTM A 276, Type 304.
- D. Wire Rope: ASTM A492-95.

2.7 FABRICATION, GENERAL

- 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. Fabricate work to be truly straight, plumb, level and square and to sizes, shapes, and profiles indicated on approved shop drawings. Ease exposed edges. Cut, reinforce, drill and tap metalwork as necessary for proper assembly and use.

1. Fabricate all miscellaneous metal supports, brackets, braces and the like required to

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- fully complete the work of this Section.
2. All mounting holes and other splicing elements shall be fabricated in the shop, sized to allow for galvanizing.
 3. Coordinate with work of other Specification Sections to ensure proper interface of various parts of the work.
- B. 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 arris. Take special care in choosing materials that are smooth and free of blemishes such as pits, roller marks, trade names, scale and roughness. Fabricate work with uniform, hairline tight joints. Form welded joints and seams continuously and grind flush and smooth.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. 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.
- E. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm), unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- F. 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.
- G. Provide weep holes where water may accumulate.
- H. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items, unless otherwise indicated.
- I. Comply with AWS for recommended practices in shop welding. Weld behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded joints of flux, and dress exposed and contact surfaces.
- J. 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.
- 2.5 FABRICATION
- A. Bridge bearings shall consist of a setting or slide plate placed on the abutment or grout pad. The bridge bearing plate which is welded to the bridge structure shall bear on this setting plate. One end of the bridge will be fixed by fully tightening the nuts on the anchor bolts at that end. The opposite end will have finger tight only nuts to allow movement under thermal expansion or contraction. Bridges in excess of 100 feet in length or bridges with dead load reactions of fifteen

(15,000) pounds or more (at each bearing location) shall have Teflon coated steel setting plates. Alternatively, UHMW-PE setting plates may be used if approved as an alternate by the engineer of record.

- B. Drain Holes: When the collection of water inside a structural tube is a possibility, either during construction or during service, the tube shall be provided with a drain hole at its lowest point to let water out.
- C. Bolt Holes: Unless otherwise specified, standard holes shall be used in high-strength bolted connections. Oversize holes may be used in any or all plies of slip-critical connections. They shall not be used in bearing-type connections. Cut, drill, mechanically thermal cut, or punch bolt holes perpendicular to metal surfaces. Do not enlarge bolt holes by burning.
- D. Bearing Holes/Slots: Cut, drill, mechanically thermal cut, or punch bearing holes/slots perpendicular to steel surfaces.
- E. Bolted Splices: Bolted splice design shall be in accordance with Section 6.13 of the "AASHTO LRFD Bridge Design Specifications" latest edition and in accordance with section 1.3 of this Section. Bolted field splices shall be located on the bridge so as to produce a structure which can be economically shipped and erected. Splices across the width of the bridge (in floor beams and wind braces) may be used, when necessary, to keep the overall structure width within reasonable limits for shipping.
- F. Welded Tubular Connections: All welded tubular connections shall be checked, when within applicable limits, for the limiting failure modes outlined in the ANSI/AWS D1.1 Structural Welding Code.
- G. All connections, fasteners and hardware to finished wood materials shall be Type 316 stainless steel.

2.6 WELDING

- A. Welding: Welding and weld procedure qualification tests shall conform to the provisions of ANSI/AWS D1.1 "Structural Welding Code", latest edition. Filler metal shall comply with the applicable AWS Filler Metal Specification (i.e. AWS A 5.28 for the GMAW Process). For exposed, bare, unpainted applications of corrosion resistant steels (i.e. ASTM A588 and A847), the filler metal shall comply with AWS D1.1, Section 3.7.3.
 - 1. Submit certification of satisfactorily passing AWS standard qualification tests for all positions with unlimited thickness of base metal.
 - 2. Welders must have a minimum of twelve (12) months experience in welding tubular structures and have demonstrated the ability to make uniform sound welds of the type required.

2.7 DECK

- A. The bridge shall be furnished with a stay-in place galvanized steel form deck suitable for pouring a reinforced concrete slab. The form deck shall be designed to carry the dead load of the wet concrete, weight of form decking, plus a construction load of 20 psf or a 150 pound concentrated load on a 1'-0" wide section of deck.

- B. The form deck shall be either smooth or composite. Composite decking shall not be used as reinforcing when designing for concentrated loads (wheel loads). The decking shall be galvanized in accordance with ASTM A525 (G60). Concrete deck design shall be performed by the Bridge manufacturer.
- C. Concrete decks shall be designed for concentrated load as specified in this Section. The wheel loads used for deck design shall be distributed per AASHTO LRFD Bridge Design Specifications and using Steel Deck Institute C-2017 Standard for Composite Steel Floor Deck-Slabs

2.8 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2.9 ELECTROLYTIC SEPARATION/CORROSION RESISTANCE

- A. Coating for electrolytic separation between steel and concrete and grout shall be a high-build coal tar epoxy providing one coat protection for steel and concrete in a variety of chemical, immersion and underground conditions, manufactured by Tnemec Company, Inc., 6800 Corporate drive, Kansas City, MO 64120-1372; Tel. 816-483-3400; Kop- Coat Inc, 436 Seventh Avenue, Pittsburgh, PA 15219-1818; 1/412/227-2700, parent company RPM, International 2628 Pearl Road - P.O. Box 777 - Medina, Ohio 44258; Phone: 330.273.5090 - Fax: 330.225.8743; Carboline Company, 2150 Schuetz Road, St. Louis, MO 63146; Phone: 800-848-4645 or 314-644-1000; FAX: 314-644-4617, or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Pre-installation Meeting: Prior to delivery, the contractor shall organize and schedule a field meeting with the Owner's Representative, the Landscape Architect and manufacturer to review the requirements of this Section, delivery and erection logistics. The meeting(s) shall be held within ten (10) days prior to the scheduled delivery time.
- B. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Bridges.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Meet the requirements established in the approved Shop Drawings.
- B. Provide bearing plates, anchorage devices and fasteners where needed to secure bridges to in-place construction.
- C. Perform cutting, drilling, and fitting required during fabrication, not in the field. Set products

accurately in location, alignment, and elevation; measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.

1. All of which shall be primed and painted to match finish surface. Visible cuts, holes, etc. shall be approved by Landscape Architect in the field.
- D. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, with uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of ornamental metal, restore finishes to eliminate evidence of such corrective work.
- E. 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.
- F. Install joint fillers as work progresses.
- G. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.
1. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.

3.3 SHOP COATINGS

- A. Galvanizing: Proper drainage and venting shall be provided for the galvanization process. All structural steel shall be zinc coat (hot-dip) galvanized per the specifications listed in ASTM A123. Hardware shall be zinc coat (hot-dip) galvanized per the specifications listed in ASTM A153.
- B. Painted Finish:
1. All finishing shall be completed in manufacturer's shop prior to shipping.
 2. All coatings shall be applied in accordance with the coating systems manufacturer.
 3. All exterior surfaces of steel shall be cleaned in prior to application of the primer.
 4. Exterior surfaces of the steel shall be painted with a two (2) coat system consisting of Epoxy Midcoat and Polyurethane Topcoat.
 5. The color of the finish coat shall be specified by the Owner at the time of the shop drawing approval.
- C. Field Painting: Field assembled connections will require field painting of the joined members. Joined faces (faying surfaces) will be shop primed but be masked off for subsequent coats. The masking will be stepped back to reveal the prime and intermediate coats. The contractor shall complete field painting of these joints and connections with paint that matches the shop applied coatings in accordance with the plans and manufacturer's recommendations. Field painting shall be completed after the bridge has been erected and set. Final acceptance of the field painting shall be by the Owner or Owner's representative.

3.4 INSTALLATION

- A. Bridge Erection: The bridge manufacturer shall determine the number, diameter, minimum grade and finish of all anchor bolts. The anchor bolts shall be designed to resist all horizontal and uplift forces to be transferred by the superstructure to the supporting foundations. Engineering design of the bridge supporting foundations (abutment, pier, bracket and/or footings), including design of anchor bolt embedment's, shall be the responsibility of the foundation engineer. The contractor shall provide all materials for (including anchor bolts) and construction of the bridge supporting foundations. The contractor shall install the anchor bolts in accordance with the manufacturer's bridge bearing dimensions.
- B. Concrete shall be as specified in Section 033000, CAST-IN-PLACE CONCRETE and per the Structural Engineers Calculations.
 - 1. Erect work square, plumb and true, accurately fitted, and with tight joints and intersections. All anchors, inserts and other members to be set in concrete or masonry shall be furnished loose by this trade to be built-into concrete and masonry by those trades. Avoid field cutting or drilling to greatest extent possible. Field welding is not permitted.
- C. Miscellaneous Items: Carefully review Drawings for miscellaneous metal items required by various trades but not specifically listed above, such as miscellaneous clip angles, electrical conduit, lighting, miscellaneous steel bracketing, and other miscellaneous metal items as indicated on Drawings, reasonably implied therefrom, or reasonably necessary for thorough completion of work.
- D. Care shall be taken that no prep work, site painting, cleaning, or other treatment of metalwork shall adversely affect adjacent finished construction.

3.5 TOLERANCES

- A. The following allowable installed tolerances are allowable variations from locations and dimensions indicated by the Contract Document and shall not be added to allowable tolerances indicated for other work.
 - 1. Allowable Variation from True Plumb: $\pm 1/8$ in. in 20 ft. - 0 in.
 - 2. Allowable Variation from True Level: $\pm 1/8$ in. in 20 ft. - 0 in.
 - 3. Allowable Variation from True Line: $\pm 1/8$ in. in 20 ft. - 0 in.

3.6 CLEANING

- A. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.
- B. Touchup Painting: Immediately after erection, clean wall surfaces, bolted connections, and abraded areas. Touch up any damaged coatings per applicator's recommendations.
 - 1. Apply by brush or spray to provide a minimum 3.0-mil dry film thickness.
 - 2. Supply owner with touch up paint in all colors.

3.7 PROTECTION

- A. Protect finishes of metal from damage during construction period with temporary protective coverings approved by metal fabricator. Remove protective covering at time of Substantial Completion.
- B. 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.

END OF SECTION

SECTION 329113 - SOIL PREPARATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes planting soils and layered soil assemblies specified by composition of the mixes.
- B. Related Requirements:
 - 1. Section 312219 "Fine Grading".
 - 2. Section 329213 "Hydroseeding".
 - 3. Section 329300 "Plants".

1.3 DEFINITIONS

- A. AAPFCO: Association of American Plant Food Control Officials.
- B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.
- C. CEC: Cation exchange capacity.
- D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.
- E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
- F. Imported Soil: Soil that is transported to Project site for use.
- G. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.
- H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.
- I. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.

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- J. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."
 - K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
 - L. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.
 - M. SSSA: Soil Science Society of America.
 - N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
 - O. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
 - P. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.
 - Q. USCC: U.S. Composting Council.
- 1.4 PREINSTALLATION MEETINGS
- A. Preinstallation Conference: Conduct conference at Project site.
- 1.5 ACTION SUBMITTALS
- A. Product Data: For each type of product.
 - 1. Include recommendations for application and use.
 - 2. Include test data substantiating that products comply with requirements.
 - 3. Include sieve analyses for aggregate materials.
 - 4. Material Certificates: For each type of imported soil and soil amendment and fertilizer before delivery to the site, according to the following:
 - a. Manufacturer's qualified testing agency's certified analysis of standard products.
 - b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
 - c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.
 - B. Samples: For each bulk-supplied material, 1-gal. volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.
 - C. Soil Amendment Quantities Diagram: Contractor shall provide a color-coded diagram for the entire site to be planted outlining each planting type with the specified quantity of soil amendments required for each. This will be used to verify the specified quantity has been installed by the Owner's representative.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For each testing agency.
- B. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.
 - 1. Laboratories: Subject to compliance with requirements, provide testing by the following:
 - a. Wallace Laboratories: wllabs.com.
 - b. Texas A&M Agrilife Extension website: soiltesting.tamu.edu
 - c. A & L Plains Agricultural Laboratories: <http://al-labs-plains.com>

1.8 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil and imported soil.
 - 1. Notify Architect seven days in advance of the dates and times when laboratory samples will be taken.
- B. Preconstruction Soil Analyses: For each soil type, perform testing on soil samples with Planting Bed Mix and Amendment Soil Mix added per instruction below indicated in part 3 - execution. A minimum of five (5) samples per mix, equally dispersed throughout the site shall be taken. Furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles. Soil analysis and written report recommendations will indicate additional amendments that should be added to the Planting Bed Mix and Amendment Soil Mix prior to full instillation of product to be deemed "perfect".
 - 1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.
 - 2. Notify Architect of the date and time when laboratory samples have been returned.
 - 3. Follow up meeting will take place to discuss preconstruction testing and proceedings.
 - 4. Owner will pay for additional soil amendment beyond what is specified at cost + delivery + 10%. All receipts must be presented in pay application to be reimbursed.

1.9 SOIL-SAMPLING REQUIREMENTS

- A. General: Extract soil samples according to requirements in this article.
- B. Sample Collection and Labeling: Have samples taken and labeled by Contractor under the direction of the testing agency at time of delivery to project site prior to installation and after additional amendments have been added per Preconstruction Testing.
 - 1. Number and Location of Samples: Sample and test at 500 cubic yard intervals with a minimum of three representative soil samples from varied deliveries per day for each soil to be used or amended for landscaping purposes.
 - 2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."
 - 3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
 - 4. Labeling: Label each sample with the date, location/delivery information keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.10 TESTING REQUIREMENTS

- A. General: Perform tests on soil samples according to requirements in this article.
- B. Physical Testing:
 - 1. Soil Texture: Soil-particle, size-distribution analysis by one of the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":
 - a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
 - b. Hydrometer Method: Report percentages of sand, silt, and clay.
 - 2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
 - 3. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
 - 4. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85% compaction according to ASTM D 698 (Standard Proctor).
- C. Chemical Testing:
 - 1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3-Chemical Methods."
 - 2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1- Physical and Mineralogical Methods."
 - 3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.

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4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.
- D. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of SSSA NAPT NCR-13, including the following:
1. Percentage of organic matter.
 2. CEC, calcium percent of CEC, and magnesium percent of CEC.
 3. Soil reaction (acidity/alkalinity pH value).
 4. Buffered acidity or alkalinity.
 5. Nitrogen ppm.
 6. Phosphorous ppm.
 7. Potassium ppm.
 8. Manganese ppm.
 9. Manganese-availability ppm.
 10. Zinc ppm.
 11. Zinc availability ppm.
 12. Copper ppm.
 13. Sodium ppm.
 14. Soluble-salts ppm.
 15. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
 16. Other deleterious materials, including their characteristics and content of each.
- E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
- F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.
1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. for 6-inchdepth of soil.
 2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. for 6-inchdepth of soil.
- 1.11 DELIVERY, STORAGE, AND HANDLING
- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.
- B. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

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2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Do not move or handle materials when they are wet or frozen.
 4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.1 PLANTING MIXES AND SOIL AMENDMENTS

- A. General: Soil amendments, fertilizers, and rates of application specified in this article are guidelines that may need revision based on testing laboratory's recommendations after preconstruction soil analyses are performed.
- B. For existing on-site Topsoil refer to Section 312219 "Fine Grading".
- C. Planting Bed Mix for shrubs, ornamental grasses season color and perennials – Consisting of the following as supplied by NewEarth or approved equal:
 1. 40% Topsoil
 2. 20% Pine Fines
 3. 20% Organic Humus
 4. 20% White Washed Sand
 5. Complete with Fertilizers as Specified
- D. Backfill Mix for pit planted trees and large specimen shrubs as supplied by NewEarth, consisting of the following:
 1. Bed Mix
 2. Organic Compost
 3. Mason sand
 4. Leafmold
- E. Soil Amendment Mix for Meadow Mixes and Bioswale Mixes – Consisting of the following as supplied by NewEarth or approved equal:
 1. 40% Topsoil
 2. 20% Pine Fines
 3. 20% Organic Humus
 4. 20% White Washed Sand
 5. Complete with Fertilizers as Specified

2.2 INORGANIC SOIL AMENDMENTS

- A. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C 33/C 33M.

2.3 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
1. Feedstock: Limited to leaves.
 2. Reaction: pH of 5.5 to 8.
 3. Soluble-Salt Concentration: Less than 4 dS/m.
 4. Organic-Matter Content: 50 to 60 percent of dry weight.
 5. Particle Size: Minimum of 98 percent passing through a 1-inch sieve.
- B. Wood Derivatives: Shredded and composted, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.

2.4 FERTILIZERS

- A. Planting bed mix fertilizer for shrubs, ornamental grasses and non-flowering perennials.
1. Nelson Plant Food "Bridgeland Bed 18-6-6"
 2. 17 pounds per 1,000 square feet.
- B. Planting bed mix fertilizer for seasonal color and Perennial Mixes.
1. Nelson Plant Food ColorStar
 2. 8 pounds per 100 square feet.
- C. Turf (seed and sod) and Giant Bermuda in Forestation
1. Nelson Plant Food water soluble 15-15-15 or approved equal.
 - a. 100 pounds per 10,000 square feet for seeded or sodded turf and Giant Bermuda. (May be broadcast or incorporated with hydromulch process)
 2. Nelson Plant Food "Bridgeland Turf Starter 13-13-13"
 - a. 500 pounds per acre broadcast 60 days after seeding or sodding.
- D. Meadow Mixes and Bioswales Mixes
1. Nelson Plant Food "Bridgeland Bed 18-6-6"
 2. 17 pounds per 1,000 square feet.
- E. Tree Installations (Individual tree plantings & forest trees)
1. Nelson Plant Food "Bridgeland Bed 18-6-6"
 2. One Pound per caliper inch of trunk measured at 6" above the rootball.
 3. Apply half of the fertilizer with the backfill around the tree and half on top of the rootball prior to mulch.
- F. Nelson Plant Food Fertilizers can be purchased direct from the supplier. Allow at least 2 weeks lead time for delivery. Contact:

Dean Nelson
Mobile 979-877-9876

PART 3 - EXECUTION

3.1 GENERAL

- A. Place planting soil and fertilizers according to requirements in other Specification Sections.
- B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.
- C. Proceed with placement only after unsatisfactory conditions have been corrected.

3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

- A. Excavation: Excavate soil from designated area(s) to a depth indicated on the drawings or in specifications sections.
- B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
- C. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand greater than 1" in diameter.

3.3 PLACING AND MIXING BEDDING MIX (shrubs, ornamental grasses perennials & seasonal color)

- A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 4 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Spread 6 inches of bedding mix and fertilizer then incorporate into 4" of subgrade by tilling
- D. Spread 6 inches of bedding mix for a total depth of 12 inches, but not less than required to meet finish grades after mixing with amendments and natural settlement.
- E. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698 and tested in-place.
- F. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.
- G. Apply Fertilizer prior to mulching.

3.4 PLACING AND MIXING SOIL AMENDMENT MIX (Meadow Mixes & Bioswale Mixes)

- A. General: Apply manufactured soil on-site in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 4 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Spread 3 inches of soil amendment mix and incorporate by tilling.
- D. Compaction: Compact planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.
- F. Apply Fertilizer prior to seeding operations.

3.5 BACKFILL FOR TREES AND LARGE SPECIMEN SHRUBS

- A. Combine soil amendments to excavated material from plant pit in equal parts to generate backfill material.
- B. Incorporate fertilizers as noted above into backfill material.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Soil will be considered defective if it does not pass tests.
- C. Prepare test reports.
- D. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

3.7 PROTECTION

- A. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Parking vehicles or equipment.
 - 3. Vehicle traffic.
 - 4. Foot traffic.
 - 5. Erection of sheds or structures.
 - 6. Impoundment of water.
 - 7. Excavation or other digging unless otherwise indicated.

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- B. If planting soil or subgrade is overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Architect and replace contaminated planting soil with new planting soil.

3.8 CLEANING

- A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.
 - 1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION 329113

SECTION 329213 – HYDROSEEDING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes materials, labor, apparatus, tools, equipment, temporary construction, transportation, and services necessary for and incidental to performing the proper completion of Work, as required to make a complete Turf Grass and/or Native Seed Mixes (via sown seed, stolon, plug, or sod) planting installation, as shown on the Contract Drawings, and as specified herein this Section.
- B. Work under this Section consists of, but is not necessarily limited to, furnishing and installing the following:
 - 1. Seeded Native Grasses and Wildflower Mixes (Hydroseeded).
 - 2. Erosion Control Blanket.
 - 3. Sodded Turf Grass.
- C. Related Sections. The following Sections contain requirements that relate to Work in this Section:
 - 1. Section 328400 – Irrigation Systems.
 - 2. Section 312219 – Landscape Grading.
 - 3. Section 329113 – Soil Preparation.
 - 4. Section 329300 – Plants.
 - 5. Section 329813 – Landscape Maintenance Period.

1.2 DEFINITIONS AND APPLICABLE STANDARDS

- A. References:
 - 1. AOSA – Association of Official Seed Analysts.
 - 2. ASPA – American Sod Producers Association.
- B. Definitions:
 - 1. Plant Material(s): Refers to living plant species, inclusive of turf grass (via sown seed, stolons, and/or sod), ornamental grasses or groundcovers (via sown seed or sown plugs) for the Project.
 - 2. Planting Area (PA): As denoted on the Contract Drawings, shall refer to areas to be installed with Plant Material(s), or areas where existing vegetation shall be protected.
 - 3. Hydro-Mulching: Refers to the practice of sowing seeds (via hydro-seeding method) or stolons (via hydro-stolonizing method) together within a slurry mixture of water, fertilizer, cellulose (wood) fiber mulch, binder additive / soil and mulch tackifier, and other additives and materials, which is sprayed uniformly on a prepared soil surface through a pressurized distribution system.
- C. Measurements:
 - 1. SQ/FT: Measurement, in square-foot.

1.3 SUBMITTALS

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- A. General: Submit each item in this Article in four (4) bound Submittal Booklets.
- B. Each Submittal Booklet under this Section shall be tabbed into specific sections, containing clearly identified (through yellow highlighter or other identification methods) and legible information on the following landscape information indicated in this Article:
1. Product Data: Manufacturer's current catalog cuts and specifications for materials included herein this Section.
 2. Certifications:
 - a. Certificates of inspection as required by law for transportation of each shipment of plant material as required.
 - b. **Seed Certification:** Certification of seed mixes from seed vendor for each seed mixture, stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, weed seed, and insert materials. Include the year of production and date of packaging if applicable. Seed mix certificate shall also include incorporated fertilizer and rate of application for hydro-mulching, as applicable.
 - c. **Sod Certification:** Certification of each seed mixture for sod, identifying sod source, including name and telephone number of supplier.
 3. Delivery Tickets: As requested, signed and stamped original delivery tickets of each material delivered to Project Site.
 4. Hydro-mulching mixture(s), inclusive of plant material, fertilizer(s), inoculate, binder additive, fiber mulch, and water. Also provide the following information:
 - a. Number of required loads and amount of water.
 - b. Area to be covered (in acres).
 - c. Equipment to be used and capacity of equipment.
 - d. Hydro-mulching subcontractor's company name, location, and license number.
- C. Samples: (Not Required)
- D. Submittals under this Article will be rejected and returned without the benefit of review by the Landscape Architect if they are difficult to read due to insufficient scale, poor image quality, or poor drafting quality; or if the required information is missing or not presented in the format as requested.
- E. No Work shall proceed under this Section until Submittal requirements indicated herein have been reviewed accordingly by the Landscape Architect.

1.4 QUALITY ASSURANCE & CONTROL

- A. Installer Qualifications:
1. Requirement: Valid Texas General Contractors License.
 2. For Contractor or Sub-Contractor installing hydro-mulching materials: Valid Texas Hydro-Mulching Certification.
 3. Engage an experienced Installer who has completed Work similar in material, design, and extent to that indicated for this Project and with a 5-year record of successful installation.
 4. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on the Project site during times that installations under this Section are in progress.
- B. Observation: Landscape Architect may observe installation Work herein this Section at Project Site for compliance with requirements for type, size, and quality. Landscape Architect retains right to observe installation of products for defects and to reject unsatisfactory or defective material or installation at any time during progress of Work. Contractor shall remove rejected Work immediately from Project site.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Seed:
1. Delivery: Furnish standard Seed in unopened and undamaged Manufacturer's standard containers bearing original certification labels showing quantity, analysis and name of Manufacturer.
 2. Storage: Protect Seed from weather or other conditions that would damage or impair the effectiveness of the product.
- B. Sod:
1. Harvest and Delivery: Harvest Sod from the source and deliver to Project Site within 24 hours. Deliver only as much Sod as can be installed in one (1) day's work. Carefully handle Sod accordingly to the requirements of the ASPA's "*Specifications for Turfgrass, Sod Materials, and Transplanting/Installing.*"
 2. Review: Sod not transplanted within this time period shall be reviewed by the Landscape Architect prior to installation.
- C. Cellulose (Wood) Fiber Mulch:
1. Labeling: Each package of Cellulose (Wood) Fiber Mulch shall be marked by the Manufacturer to show the air dry weight content.
 2. Storage: Protect from weather or other conditions that would damage or impair the effectiveness of the product.
- D. Binder Additive / Soil and Mulch Tackifier:
1. Labeling: Each package of Binder Additive / Soil and Mulch Tackifier shall be marked by the Manufacturer to show the air dry weight content.
 2. Storage: Protect from weather or other conditions that would damage or impair the effectiveness of the product.
- E. Hydromulching Slow-Release Fertilizer:
1. Delivery: Furnish material in unopened and undamaged Manufacturer's standard containers bearing original certification labels showing quantity, analysis and name of Manufacturer.
 2. Storage: Protect material from weather or other conditions that would damage or impair the effectiveness of the product.
- F. Granular Soil Conditioning Material & Fertilizer:
1. Delivery: Furnish material in unopened and undamaged Manufacturer's standard containers bearing original certification labels showing quantity, analysis and name of Manufacturer.
 2. Storage: Protect material from weather or other conditions that would damage or impair the effectiveness of the product.
- G. Mycorrhizal Inoculum for Hydromulch-type Applications:
1. Delivery: Furnish material in unopened and undamaged Manufacturer's standard containers bearing original certification labels showing quantity, analysis and name of Manufacturer.
 2. Storage: Protect material from weather or other conditions that would damage or impair the effectiveness of the product.
- H. Wood Fiber Erosion Control Blanket:
1. Delivery: Furnish material in unopened and undamaged Manufacturer's standard containers bearing original certification labels showing quantity, analysis and name of Manufacturer.
 2. Storage: Protect material from weather or other conditions that would damage or impair the effectiveness of the product.

1.6 PROJECT SITE CONDITIONS

- A. General Requirements: Installation under this Section shall be performed only during the time of day and during seasons when satisfactory results can be expected, unless authorized by the Landscape Architect.
 - 1. Seeds: Install immediately after finish grading and irrigation installation are accepted.
 - 2. Sod: Install immediately after finish grading and irrigation installation are accepted.
- B. Climate Restrictions: Do not install Plant Materials under this Section during rainy or inclement weather.
- C. Hydro-mulching Operations:
 - 1. Irrigated Areas: Commence Work within fourteen (14) calendar days after the completion and acceptance of Soil Preparation (per Section 329113 – Soil Preparation.) in planting areas.
 - 2. Un-irrigated Areas: Commence work only between October 1st through February 28th, or as directed by the Landscape Architect. Should Contractor commences installation outside of this time frame, Contractor is responsible to provide temporary irrigation, as required, to un-irrigated areas to insure proper germination and growth establishment of the hydro-mulching materials to satisfy an minimum of 95% coverage of the hydro-mulched areas to satisfy Final Acceptance requirements.

1.7 SUBSTITUTIONS

- A. Consideration: Materials to be considered equal to the Materials indicated herein this Section shall be reviewed by the Landscape Architect. Materials with equal performance characteristics produced by other Manufacturer's and/or Distributors may be considered, providing deviations in dimensional size, color, composition, operation, and/or other characteristics do not change the design concept, aesthetic appearance, nor intended performance, as solely judged by the Landscape Architect. The burden of proof on product equality is on the Contractor.
- B. Specific reference to Manufacturer's names and products specified herein are used as standards of quality. This implies no right to the Contractor to substitute other materials without prior written approval by the Landscape Architect for Work under this Section.
- C. Materials substituted and installed by the Contractor, without prior written approval by the Landscape Architect, may be rejected. Contractor shall not be entitled to be compensated by the Owner where the Contractor has installed rejected substitutions without receiving prior written approval.
- D. Contract Price: Substituted Materials under this Section shall not increase the Contract price.

1.8 WARRANTY

- A. Time Period: Warrant Plant Materials under this Section are established and in a healthy and flourishing condition of active growth six (6) months from date of Final Acceptance.
- B. Appearance During Warranty:
 - 1. Native Grasses and Wildflower areas shall be free of dead or dying patches, and shall show foliage of a normal density, size and color.

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- C. Delays: Delays caused by the Contractor in completing planting operations under this Section which extend the planting into more than one (1) planting season shall extend the Warranty Period correspondingly.
 - D. Coverage: Warrant growth and coverage of installations under this Section to the effect that a minimum of 95% of the area planted shall be covered and of acceptable appearance with the specified planting after one (1) growing season, with no bare spots.
 - 1. Exceptions: Contractor shall not be held responsible for failures due to neglect by Owner, vandalism, or natural disaster during Warranty Period. Report such conditions in writing.

1.9 FINAL ACCEPTANCE AND LANDSCAPE MAINTENANCE PERIOD

- A. Refer to Section 329813 – Landscape Maintenance Period.

PART 2 - PRODUCTS

2.1 PLANT MATERIALS

- A. General:
 - 1. Provide hydroseeded installation of Native Grass and Wildflower areas as designated on the Contract Drawings.
 - 2. Provide sodded installation of Turf Grass areas as designated on the Contract Drawings.
- B. Turf Grass Sod Material:
 - 1. Provide certified Turf Grass Sod complying with ASPA's Specifications for thickness, size, strength, moisture content, and mowed height. Provide Sod of grass species and varieties selected, proportioned by weight, and minimum percentages of purity, germination, and maximum percentage of weed seed.
 - 2. Sod shall consist of live, growing, mature nursery-grown field stock, and shall arrive with a lush appearance, uniform texture, and a deep green color typical of the selected turf grass species.
 - 3. Sod shall be machine-cut from the nursery field with a minimum of one-half inch (1/2") of soil that completely covers the roots of the Sod. Sod shall contain a healthy, virile root system of dense, strong, thickly matted roots throughout, with no dead or dry edges, and capable of vigorous growth and development when planted. Sod shall be sufficiently dense to bear handling and placement without tearing.
 - 4. Sod shall be free of thatch, diseases, and harmful insects, and reasonably free from noxious or broadleaf weeds or other grasses, and shall not contain any other matter deleterious to its growth or which might affect its subsistence or hardiness when transplanted.
 - a. Sod shall be considered "weed free" if no more than ten (10) weeds are found per 100 SF of Sod.
 - b. Entire lot of Sod shall be rejected if found to contain the following weeds: common Bermuda grass, quackgrass, nutgrass, johnsongrass, poison ivy, nimbleweed, thistle, bindweed, bentgrass, perennial sorrel, or bromegrass.
 - 5. Turf Grass Sod Species: Emerald Zoysia, San Antonio Sod Company, (830) 222-6821.

2.2 HYDROMULCHING MATERIALS (HYDROSEEDING/HYDROSTOLONIZING)

- A. Seed Mix:
 - 1. Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.
 - 2. Contractor shall furnish certification showing origin of all seed and Pure Live Seed (PLS) purity (times (x)) percent germination. Each bag of seed shall be tagged and sealed by the producer in accordance with the U.S. Department of Agriculture's rules and regulation under the Federal Seed Act and applicable State seed laws or other local certification authority within the state of origin. The label shall indicate analysis of seed and date of analysis. Seed may be premixed by the seed dealer and appropriate data indicated on the bag label for each variety.
 - 3. State-certified seed of species as specified.
 - 4. Seed shall be domestic grown and shall be furnished in sealed standard containers, each of which carries the analysis label.
 - 5. Seed which has become wet, moldy, musty or otherwise damaged will not be acceptable.
 - 6. Seed Mix Rate is given in pounds of Pure Live Seed (PLS) per acre. Refer to Contract Drawings for Seed Mix species.
 - a. Minimum Purity: 95%.
 - b. Minimum Germination: 90%.

- B. Water: Clean, fresh, potable, free of deleterious materials, as furnished by Owner. Transport as required.

- C. Wood Fiber Mulch, pre-blended with Organic Binder Additive / Tackifier:
 - 1. Composition: Wood Fiber Mulch shall be composed of 100% virgin thermally-refined wood fiber, dark-green-colored, sterilized to contain no germination or growth inhibiting factors. It shall be consistent in texture, which disburses evenly and remains suspended in agitated water. Mulch shall be pre-blended by the Manufacturer with a high-viscosity, non-toxic, hydro-colloid guar gum-based Tackifier, minimum 3%.
 - 2. Unacceptable Materials: Paper (Cellulose) Fiber Mulch, or a blended Wood Fiber/Paper (Cellulose) Fiber Mulch shall not be used.
 - 3. Weight: Weight specification of Wood Fiber Mulch refers only to air dry weight of the fiber material. Absolute air dry weight is considered equivalent to 10% moisture.
 - 4. Dispersion in Slurry: Wood Fiber Mulch shall be manufactured in such manner that after addition to and agitation in slurry tanks with fertilizer, seed, water and other approved additives, fibers in the material will become uniformly suspended to form a homogeneous slurry.
 - 5. Absorption Capacity: When hydraulically sprayed on the ground, the Wood Fiber Mulch material will form a blotter-like groundcover impregnated uniformly with seed, which will allow the absorption of moisture and allow rainfall to percolate to the underlying soil.
 - 6. Property Analysis (meet the following minimum requirements):
 - a. Moisture Content (9%-12% +/- 3%, Wet Weight Basis).
 - b. Organic Matter (96%, +/- 2%, Oven Dry Weight Basis).
 - c. Ash Content (.7%, +/- 0.2%, Oven Dry Weight Basis).
 - d. Wood Fiber: 97%.
 - e. pH (4.5-4.8, +/- 0.5).
 - f. Moisture Holding Capacity (grams of water/100 grams oven dry fiber): Minimum 1150 grams of fiber.
 - 7. Products & Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

Product / Manufacturer	Binder Additive / Tackifier	Application	Rate @ lb/Ac
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Cowed Fibers® 2000 / Profile Products, LLC	Pre-blended in product as provided by Manufacturer.	<2:1 Slopes to 1:1 Slopes.	2500
		</= 3:1 Slopes to </= 2:1 Slopes	2000
		Moderate to 3:1 Slopes	1500
EcoFibre® Tac Mulch / Canfor Corporation	Pre-blended in product as provided by Manufacturer.	<2:1 Slopes to 1:1 Slopes.	2500
		</= 3:1 Slopes to </= 2:1 Slopes	2000
		Moderate to 3:1 Slopes	1500

D. Hydromulching Slow-Release Fertilizer:

1. Pelleted- or granular-form fertilizer, organic-based, long-lasting, controlled-release, uniform in composition, free flowing, singular manufacturer-blended combination of soil conditioning material and fertilizer with micronutrients, suitable for application with approved equipment. It shall not contain any sewage sludge or manure-based products, and shall contain the guaranteed minimum available analysis range. Installed in the hydroseed slurry mix, and consisting of the following minimum available percentages by weight of plant food:

<i>Element/Material</i>	<i>Targeted Property Range</i>
Nitrogen (N)	5.0% to 6.0%
Phosphoric acid (as P2O5)	2.0% to 3.0%
Potash (as K2O)	1.0% to 4.0%
Humic Acids	15.0% to 20.0%
Calcium (Ca)	7.0%
Sulfur (S)	0.0% to 5.0%

2. Products, Manufacturers and Associated Rates of Application: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. *Tri-C 6-2-4*, Tri-C Enterprises LLC, Chino, CA, 800-927-3311.
 - 1) Application Rate at 70 lbs. per 1,000 square feet of planting area.
 - b. *Gro-Power Plus 5-3-1*, Gro-Power, Chino, CA. 909-393-3744.
 - 1) Application Rate at 200 lbs. per 1,000 square feet of planting area.
 - c. or equal, as approved by the Landscape Architect.

E. Mycorrhizal Inoculum for Hydromulch-type Applications: To be added as part of the Hydromulching operations, providing a dual soil-conditioning biological inoculum system of endo-and ecto- Mycorrhizal to further aid the immature plant's ability to efficiently uptake available soil nutrients and also increase resistance to drought.

1. Products & Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. *Tri-C Endo 120*, Tri-C Enterprises LLC, Chino, CA, 800-927-3311.
 - b. *Gro-Life*, Gro-Power, Gro-Power, Chino, CA. 909-393-3744.
 - c. or equal, as approved by the Landscape Architect.

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2. Provide at the prescribed application rate per the Manufacturer's written recommendations, or as indicated herein this Section.
 3. Selected Manufacturer of the Hydromulching Slow-Release Fertilizer and the Mycorrhizal Inoculum for Hydromulch-type Applications shall be of the same manufacturer.

2.3 MIXTURES (Refer to Part III herein this Section)

- A. Seed Mix Supplier: Native American Seed (800) 728-4043, info@seedsource.com.

2.4 EROSION CONTROL BLANKET

- A. Wood fiber erosion control blanket: Item #7059, 8 feet x 90 feet as supplied by Native American Seed (800) 728-4043, info@seedsource.com.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions:
 1. Grades: Verify that grades are within one-inch (1") plus or minus (+/-) of the required finished grades. Verify that applicable soil preparation and erosion control materials have installed under other Sections of the Contract Specifications. Report all variations in writing.
 2. Irrigation System: Verify that the irrigation system is installed and 100% coverage of the subject area is complete, tested, and in full working order. Complete installation of the irrigation system is a prerequisite for commencing work under this Section.
 3. Stones, Weeds, and Debris: Verify that planting areas under this Section are clear of stones larger than 1-1/2 in. diameter, and that weeds, debris and other extraneous materials have been removed prior to installation.

3.2 PREPARATION

- A. Limit sub-grade preparation to areas that will be planted in the immediate future.
- B. Excessive Soil Moisture: Do not commence Work under this Section when Soil Moisture Content is so great that excessive compaction to the soil will occur during installation. Owner and/or Landscape Architect shall be the sole judges as to a acceptable soil moisture content.
- C. Inadequate Soil Moisture: Apply water, in quantity as necessary, to bring soil to a optimum moisture content for installation under this Section. Do not work soil when it is so dry that dust will form in air or where clods will not readily break apart.
- D. Cultivation: Planting areas shall be ripped or cultivated to a depth of three inches (3") immediately prior to hydroseeding. Refer to Section 329113 – Soil Preparation.
- E. Install Erosion Control Blankets in the areas as indicated in the contract documents. Cut to size as required. Secure blankets with 6 inch 8 gauge galvanized landscape staples at 24 inches on center.

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- F. Hydro-mulching of Non-irrigated Grass/Wildflowers Areas: Installation shall only occur during the period between October 15th and December 1st.
 - G. Contractor's Option: Perform manual hand seeding, machine, or hydro-mulching of planting areas.

3.3 TURF GRASS SOD INSTALLATION

- A. Delivery: Sod slabs shall be delivered on pallets and installed at the Project Site within twenty-four (24) hours after harvesting. Sod not installed within this time period shall be inspected and approved or rejected by the Landscape Architect. Do not lay sod if dormant.
- B. Protection: Protect root system of the sod from exposure from the weather, including dehydration, contamination, and heating during transportation to the site and delivery. In hot, dry, or windy weather conditions, stacked sod at the Project Site shall be lightly sprinkled with water to prevent sod slab edges from drying out.
- C. Allowance Period for Soil Settlement: Turf Grass Sod installation shall be started only after soil preparation and finish grading has been completed and soil has been permitted to settle under full irrigation during deep-water leaching operations for a minimum of two (2) weeks.
- D. After Allowance Period of Soil Settlement has expired, the areas to be sodded shall be loosened to a depth of two-inches (2"), raked, and floated to the final finished grade by a standard acceptable method. Finished areas shall be kept moist, even, and smooth, free from ridges and depressions, rocks, debris, and dirt clods, and reasonably well firmed.
- E. Compaction and Final Grading: Contractor shall provide sod beds that will not "footprint. Lightly rake and roll soil with two-hundred (200) pound water-ballast roller (filled 1/3 – 1/2 full), and bring level firm to finish grade. Final rolling shall be at right angles to slopes to prevent erosion. Sub-soil finish grade shall be sufficiently below the final grade to allow for the thickness of the sod material. Where applicable, newly sodded areas shall blend and match with existing turf grass areas so as to produce a smooth, unified field of turf grass.
- F. Application of Fertilizer: Apply the Pre-plant Starter Fertilizer evenly throughout the area to be sodded, at the prescribed application rate. Evenly distribute fertilizer by applying equal quantities in two (2) directions at right angles to each other.
- G. Raking: After broadcasting starter fertilizer, lightly rake and smooth seed bed surface to 1/4 in. depth. Install sod immediately thereafter, provided the sod bed has remained in a friable condition.
- H. Sodding Operations:
 - 1. Lay sod to form a solid mass with tightly fitted butt joints, with "green-side up".
 - 2. Starter Strip: Lay first row of sod in a straight line, with subsequent rows parallel to and tightly against each other.
 - 3. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads (in a running-bond-type pattern) to offset joints in adjacent courses.
 - 4. Avoid damage to sub-grade or sod during installation.
 - 5. Tamp and roll lightly to ensure full contact with sub-grade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

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6. Lay sod parallel to the lay of the sodded area. Lay sod across angle of slopes exceeding 3:1, beginning at the bottom of slope area.
 7. Anchor sod on slopes exceeding 6:1 with wood stakes spaced at two (2) pegs per square yard. Provide not less than two (2) anchors per sod strip to prevent slippage.
 8. Cutting: Use a sharp knife to cut sod to fit straight segments or curves. Trim sod in straight lines when planting beds are linear or parallel to the hardscape elements. Trim sod slabs in a smooth, continuous curve when sod edges are placed against curvilinear hardscape elements.
 9. Mulch Ring at Sod in Turf Grass Areas: Trim sod in clean diameter circles around the perimeter of trees planted in turf grass areas, as indicated on the Contract Drawings. The Mulch Ring circles shall have the tree trunk located in the middle of the circle. Provide Organic Wood Mulch in these areas, at the designated thickness specified herein this Section.
- I. Initial Watering: Saturate sod with fine water spray within two (2) hours of planting. Do not lay entire amount of sod before beginning watering. Water in lightly, when a relatively large area of sod has been placed.
1. During first week, water daily to supplement rainfall as necessary to maintain moist soil to a minimum depth of two-inches (2") below the sod until sod has rooted. Repeat watering at regular intervals until sod has established itself.
 2. Once established, decrease the watering frequency and increase the amount of water per application.
- J. Protection on Site: Erect temporary barricades, warning signs & flags, as required. Protect the sodded areas against vehicular and pedestrian traffic until sodded areas have established growth to the satisfaction of the Owner or Landscape Architect.
- K. Sod Establishment:
1. Mow and maintain turf height recommended by the turf grass nursery. Do not cut more than 40% of the total grass blade length in one (1) single mowing.
 2. Replace dead or dying sod with new sod.
 3. Eradicate weeds between second and third mowing. Apply herbicides uniformly at the Manufacturer's recommended rate.
 4. Apply a second application of the Pre-plant Starter Fertilizer uniformly to the surface at the Manufacturer's recommended application rate thirty (30) days after seeding.
 5. Dispose of protective barricades and warning signs at the termination of the sod establishment period.

3.4 HYDROSEED/HYDROSTOLON (HYDROMULCHING) INSTALLATION

- A. General Application Requirements:
1. Areas to receive hydro-mulching are to be applied by a licensed and approved hydro-mulch contractor, with qualified applicators. Provide registration to the Landscape Architect.
 2. Weed Control: Apply pre-plant weed control to the hydro-mulching areas, to the satisfaction and approval of the Landscape Architect, prior to hydro-mulching operations.
 3. Install irrigation system, plant container stock, and perform fine grading and specified soil preparation operations, as required, to the satisfaction and approval of the Landscape Architect prior to commencing hydro-mulching operations.
 - a. Restrictions: Do not perform hydro-mulching operations when winds exceed fifteen (15) mph.
 4. Hydro-mulching Equipment: Hydraulic equipment used for the application of the hydro-mulching slurry mixture shall be of the type as approved by the Landscape Architect.

- a. Equipment shall have a built-in agitation system with an operating capacity sufficient to agitate, suspend, and homogeneously mix a slurry containing one-thousand-two-hundred (1,200) pounds of mulching material.
 - b. The slurry distribution lines and nozzles shall be large enough to prevent stoppage and shall provide even distribution of the slurry.
 - c. The slurry tank shall have a minimum capacity of one-thousand-five-hundred (1,500) gallons and shall be mounted on a traveling unit which will place the slurry tank and spray nozzles within sufficient proximity to the areas to be sprayed so as to provide uniform distribution without waste.
5. Pre-Application Cleaning: Prior to preparing hydro-mulching slurry, thoroughly clean and flush hydro-mulching storage tank, agitators, hoses, nozzles, and other equipment that will come into contact with slurry mixture free from residue from previous hydro-mulching applications. Verify with Owner's Representative a location where cleaning can be demonstrated, and perform flushing operations to the visual satisfaction of the Owner's Representative.
- a. When different hydro-mulching seed mixtures are being applied for the project using the same hydro-mulching equipment, Contractor shall provide a thorough cleaning of the hydro-mulching equipment between applications to insure that no cross-contamination occurs between the mixture recipes.
6. Timing: Hydro-mulching operations shall be applied twenty-four (24) hours prior to or following a storm event. Verify application date(s) with the Landscape Architect prior to installation.
7. Hydro-mulching slurry mixes that have not been applied within thirty (30) minutes (forty-five (45) minutes maximum) after mixing shall be rejected.
- B. Mixing/Blending: In a clean hydro-seeding vessel, fill vessel with water to at least one-third (1/3) capacity (high enough to cover agitators) prior to adding any hydro-mulching ingredients. Continue to fill vessel with water and add all specified liquid-based ingredients while agitators are in motion. Once full with the accurate amount of ingredients in solution, add the specified dry ingredients, and continue mixing/agitating until uniformly blended into a homogenous slurry suitable for hydraulic application. Continue to mix tank a minimum of ten (10) minutes prior to application. Note that correct mixing and proper application are key factors in obtaining satisfactory performance.
- C. Application: Apply slurry uniformly to hydro-mulched areas in a one- (1) step process. Slurry shall be applied by a qualified applicator, at a minimum rate of three-thousand (3,000) gallons/acre (higher rates may be required) evenly over the entire area to be treated. Caution should be taken to avoid creating puddles or runoff. The slurry must be sprayed from multiple directions and angles to ensure complete and proper coverage. Apply slurry in a sweeping motion so as to fall like rain, allowing the slurry to build upon itself on the ground until a coating is achieved that resembles a thick, blotter-like groundcover. Treated areas shall not be disturbed after application.
1. A Certificate of Compliance shall be furnished to the Landscape Architect, stating that the appropriate quantities, blending and application methods as specified herein have been properly followed.
 2. Hydro-seed Mixture (for Wildflower, Ornamental Grass, and/or Slope Stabilization Applications; One (1)-Step Process):

<i>Material</i>	<i>Quantity</i>
Wildflower, Ornamental Grass, and/or Slope Stabilization Seed Mix	Refer to requirements herein this Section for selected Wildflower, Ornamental Grass, and/or Slope Stabilization Seed Mix and Application Rate(s).

Wood Fiber Mulch, pre-blended with Binder Additive / Soil and Mulch Tackifier	Per Selected Manufacturer's Recommended Application Rate, per slope condition.
Soil Stabilizing Emulsion Blend Additive	Per Manufacturer's Recommended Application Rate.
Hydromulching Slow-Release Fertilizer	Per selected Manufacturer's Recommended Application Rate.
Mycorrhizal Inoculum for Hydro-mulch-type Applications.	Per Selected Manufacturer's Recommended Application Rate
Water	As required to provide a homogenous slurry suitable for hydraulic application.

- D. Germination: Hydro-mulched areas shall be kept thoroughly moist to insure germination and growth of the sown plant material. Do not allow the plant material bed to dry out at any time. Irrigate hydro-mulched areas thoroughly immediately after the application, for a minimum of twenty-one (21) to twenty-four (24) days after planting, or until the new growth of the plants is sufficiently well-established, as per the Landscape Architect's instructions.
- E. Protection of Hydro-Mulched Areas: Hydro-mulched areas shall be protected against foot or vehicular traffic and other use immediately after hydro-mulching installation is completed. Contractor shall install temporary warning signs, stakes, twine, flagging, etc., as required, around the perimeter of the areas that have been hydro-mulched to deter activity from disturbing the germination and growth of the hydro-mulched areas. Contractor shall remove protection as instructed by the Landscape Architect.
1. Hydro-mulched areas that do not germinate satisfactorily, in the sole opinion of the Landscape Architect, shall be re-hydro-mulched at approximately fourteen (14)-day intervals, using the same specified materials and installation methodology until an overall acceptable stand of growing plant material is produced.

3.5 FIELD QUALITY CONTROL

- A. Tests: Samples of materials may be taken and tested for conformity to the Contract Specifications at any time by the Landscape Architect.
- B. Rejected Materials: Remove rejected materials immediately from the site at Contractor's expense. Pay cost of testing of materials not meeting the Contract Specifications.
- C. Intent: A consistent, thriving, and even cover of installed seed, sod, stolons, plugs, or hydro-mulching materials is the intent of this Section.
- D. Satisfactory Installation: Hydro-mulching installation shall meet the following criteria, as determined by the Landscape Architect:
1. 1. At the end of the Landscape Establishment Period, a healthy, uniform, close stand of hydroseeded/hydrostolonized plant material has been established, free of weeds and surface irregularities, with coverage exceeding 90% percent coverage with no bare spots exceeding 6"

inches. Failure to comply with this requirement shall extend the Landscape Establishment Period accordingly until the requirement is met.

3.6 CLEANING

- A. Hydro-mulching Overspray: Upon completion of hydro-mulching operations, clean off any slurry overspray from drainage devices, paving surfaces, plant materials, and site or architectural features. Contractor shall exercise caution in cleaning these areas so as not to wash away previously hydro-mulched areas (as applicable).
- B. Erosion: Immediately restore eroded areas. Keep adjacent paved surfaces cleaned of dirt, mud or stains and organic debris.

END OF SECTION 329200

SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Trees, shrubs, perennials, grasses and groundcovers.
- 2. Tree stabilization.
- 3. Landscape edgings.

B. Related Requirements:

- 1. Section 32913 "SOIL PREPARATION".
- 2. Section 329200 "LAWN AND GRASSES" for turf grass (lawn) and meadow planting, hydroseeding, and erosion-control materials.
- 3. Section 329400 "LANDSCAPE MAINTENANCE".

1.3 UNIT PRICES

- A. Unit prices apply to additions to and deletions from the Work as authorized by Change Orders.

1.4 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than the minimum root spread according to ANSI Z60.1 for type and size of plant required.
- C. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- D. Finish Grade: Elevation of finished surface of planting soil.
- E. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also

include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

- F. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- G. Planting Area: Areas to be planted.
- H. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "SOIL PREPARATION" for drawing designations for planting soils.
- I. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- J. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- K. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- L. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.5 COORDINATION

- A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
 - 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.6 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.7 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
 - 2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

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- B. Samples for Verification: For each of the following:
1. Organic Mulch: 1 gallon volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
 2. Weed Control Barrier: 12 by 12 inches.
 3. Root-Ball-Stabilization Materials: Posts
 4. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.

1.8 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
1. Manufacturer's certified analysis of standard products.
 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.
- D. Sample Warranty: For special warranty.

1.9 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.10 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.
1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 2. Experience: Five years' experience in landscape installation in addition to requirements in Section 014000 "Quality Requirements."
 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
 - a. Landscape Industry Certified Technician - Exterior.
 5. Pesticide Applicator: State licensed, commercial.

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- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
 - 1. Selection of plants purchased under allowances is made by Architect, who tags plants at their place of growth before they are prepared for transplanting.
 - C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
 - 1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
 - 2. Other Plants: Measure with stems, petioles, and foliage in their normal position.
 - D. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
 - 1. Notify Architect of sources of planting materials 90 days in advance of delivery to site.
 - 2. Procure and secure 200 gallon (60 inch box)specimen trees at the award of the contract to insure that they will be available. The trees will be reviewed and tagged at the grower by the architect.
 - a. Purchase Order: Provide, grow and maintain all plant materials designated on approved Purchase Order.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- B. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.
- C. Deliver bare-root stock plants within 24 hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.
- D. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie

trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

- E. Handle planting stock by root ball.
- F. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
 - 1. Do not remove container-grown stock from containers before time of planting.
 - 2. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.12 FIELD CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

1.13 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
 - b. Structural failures including plantings falling or blowing over.
 - c. Faulty performance of tree stabilization.
 - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Periods: From date of Substantial Completion.
 - a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
 - b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.
 - c. Annuals: Three months.
 - 3. Include the following remedial actions as a minimum:
 - a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
 - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.

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- c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
 - d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
 - 1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots are unacceptable.
 - 2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.
- C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
- D. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.
- E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.
- F. Annuals: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery.

2.2 FERTILIZERS

- A. Refer to 329113 SOIL PREPARATION.

2.3 PLANTING SOIL AND PLANT PIT BACKFILL

- A. Refer to 329113 SOIL PREPARATION.

2.4 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
 - 1. Type: Shredded hardwood.
 - 2. Size Range: 3 inches maximum, 1/2 inch minimum.
 - 3. Color: Natural.
- B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through a 1-inch sieve; soluble-salt content of 2 to 5 dS/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - 1. Organic Matter Content: 50 to 60 percent of dry weight.
 - 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

2.5 PESTICIDES

- A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.6 TREE-STABILIZATION MATERIALS

- A. Trunk-Stabilization Materials:
 - 1. Upright and Guy Stakes: 8' long steel T-posts weighing 1.33 pounds per foot and painted green.
 - 2. Tree Ties: Non-stretch, biodegradable cotton, dyed dark-green color, one-inch (1") wide x eighteen-inches (18") long, with one-inch (1") brass grommets at each end. Break strength at 260 lbs. nominal.
 - a. Product: #3018 *Original Treestrap*®, GCS.
 - 3. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch in diameter.

2.7 LANDSCAPE EDGING / HEADER: Refer to the Drawings.

2.8 MISCELLANEOUS PRODUCTS

- A. Drainage Gravel: Washed, sound crushed stone or gravel complying with ASTM D 448 for Size No. 8.

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- B. Planter Filter Fabric: Mirafi 135N as supplied by San Jacinto Environmental or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
 - 3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 4. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways. Refer to Section 329213 "Hydroseeding" for erosion control blanket.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.
- D. Lay out plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.3 PLANTING AREA ESTABLISHMENT

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."
- B. Placing Planting Soil: Place manufactured planting soil over exposed subgrade according to Section 329113 "Soil Preparation."

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- C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
 - D. Application of Fertilize: Apply fertilizer for pit planted material and bedding plants according to Section 329113 "Soil Preparation."

3.4 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits.
 - 1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
 - 2. Excavate approximately three times as wide as ball diameter for container-grown stock.
 - 3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
 - 4. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
 - 5. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
 - 6. Maintain supervision of excavations during working hours.
 - 7. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
- B. Backfill Soil: Subsoil and topsoil removed from excavations may not be used as backfill soil unless otherwise indicated.
- C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
- D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
- E. Fill excavations with water and allow to percolate away before positioning trees and shrubs. Conditions permitting the retention of water in planting beds or pits for more than 24 hours or percolation of less than 1" per hour shall be brought to the attention of the Landscape Architect.

3.5 TREE, SHRUB, AND VINE PLANTING

- A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

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- C. Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches above adjacent finish grades.
 - 1. Backfill: According to Specification Section 329113 Soil Preparation
 - 2. Carefully remove root ball from container without damaging root ball or plant.
 - 3. Thoroughly mix fertilizer into backfill mix.
 - 4. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 - 5. Continue backfilling process. Water again after placing and tamping final layer of soil.
 - D. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 MECHANIZED TREE-SPADE PLANTING

- A. Trees shall be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.
- B. Use the same tree spade to excavate the planting hole as will be used to extract and transport the tree.
- C. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.
- D. Cut exposed roots cleanly during transplanting operations.
- E. Plant trees following procedures in "Tree, Shrub, and Vine Planting" Article.
- F. Where possible, orient the tree in the same direction as in its original location or as directed by Landscape Architect.

3.7 TREE, SHRUB, AND VINE PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Prune, thin, and shape trees, shrubs, and vines as directed by Landscape Architect.
- C. Do not apply pruning paint to wounds.

3.8 TREE STABILIZATION

- A. Staking of trees is to be used by the Contractor, who will be responsible for material remaining plumb and straight for all given conditions through the guarantee period. Tree support shall be done as outlined on the following tables.

<u>Tree</u>	<u># Stakes</u>
30 gallon & smaller	2

45 gallon to 100 gallon	3
200 gallon and greater	4

1. Site-Fabricated, Staking-and-Guying Method:

- a. Securely attach guys to stakes 30 inches long, driven to grade. Adjust spacing to avoid penetrating root balls or root masses.
- b. Locate first stake on prevailing windward side of tree and as close to the main trunk as practical, avoiding root injury. Stake shall be driven at least 18" into firm ground.
- c. Tie tree to stake using approved tree tie. Tie shall be located midway within tree crown or at location approximately 2/3 of the overall height of the tree. Locate tie just above major side branch in order to deter slippage of tie.
- d. Locate remaining stakes equally spaced around the tree and secure as indicated above.

3.9 GROUND COVER AND PLANT PLANTING

- A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.
- B. Use planting soil for backfill as identified in specification section 329113 Soil Preparation.
- C. For container plants in erosion control blanket areas cut an X in the fabric at the same size as the container.
- D. Dig holes large enough to allow spreading of roots.
- E. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.
- F. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- G. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- H. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.10 PLANTING AREA MULCHING

- A. Mulch backfilled surfaces of planting areas and other areas indicated.
 1. Trees and Treelike Shrubs in Turf Areas: Apply organic mulch ring of 2-inch average thickness, with 36-inch radius around trunks or stems. Do not place mulch within 6 inches of trunks or stems.
 2. Organic Mulch in Planting Areas: Apply 2-inch average thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

3.11 EDGING INSTALLATION

- A. Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches apart, driven below top elevation of edging.
- B. Shovel-Cut Edging (Where indicated): Separate mulched areas from turf areas with a 45-degree, 4- to 6-inch-deep, shovel-cut edge as indicated on Drawings.

3.12 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.
- B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.13 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.
- C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.14 REPAIR AND REPLACEMENT

- A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.
 - 1. Submit details of proposed pruning and repairs.
 - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
 - 3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.
- B. Remove and replace trees that are more than 25 percent dead or in an unhealthy condition, as determined by the Landscape Architect, before the end of the corrections period or are damaged during construction operations that Landscape Architect determines are incapable of restoring to normal growth pattern.

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1. Provide new trees of same size as those being replaced for each tree.
 2. Species of Replacement Trees: Species selected by Architect.

3.15 CLEANING AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.
- C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.16 MAINTENANCE SERVICE

- A. Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
 1. Maintenance Period: Three months from date of Substantial Completion.
- B. Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
 1. Maintenance Period: Three months from date of Substantial Completion.

END OF SECTION

SECTION 329400 - LANDSCAPE MAINTENANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS: The Drawings, Division 0 and Division 1 apply to work under this Section.

- A. Section 329213; "Hydroseeding".
- B. Section 329300, "Plants".

1.2 SCOPE OF WORK:

A. Work included in Base Bid:

- 1. Monitoring adjustment and minor repair of the landscape irrigation system.
- 2. Mowing, edging and trimming of lawn areas.
- 3. Mowing of Love Grass and Native Grass Plantings
- 3. Pruning and trimming of plant materials.
- 4. Weed, cultivating and cleaning of planting beds, turf areas, and Native grass areas.
- 5. General site clean up; removal of trash and products of maintenance.
- 6. Applications of fertilizers, ant control, insecticides and herbicides.
- 7. Daily trash cleanup and removal.
- 8. Pruning and trimming of trees.
- 9. Mulching trees, shrubs, groundcovers and seasonal color.
- 10. Extra services as needed.

B. Work Not Included in Base Bid: (Extra Service)

- 1. Street cleaning - other than that required as a result of maintenance operations.
- 2. Replacement of plant material - other than that required under the one year warranty requirement.
- 3. Compost amendment application
- 4. Aerating lawn areas.
- 5. Overseeding with cool-season grasses.
- 6. Application of pre/post emergents.
- 7. Additional clean-up and/or plant material replacement relating to natural weather events including hurricanes, tornadoes, severe thunderstorms, major rain events causing flooding, freezing temperatures, ice/ice storms, extended periods of draught and snow.

1.3 EXTRA SERVICES:

- A. The intent of the ninety (90) DAY maintenance period is to provide a comprehensive maintenance program to include all required services, except those services specifically excluded, to perform the work for the stated time period.
- B. All services not included in the list of Base Bid items shall be considered "extra services" and will be charged for separately according to the nature of the item of work. The consent and authorization of the Owner's representative or their authorized representative must be obtained prior to the performance or installation of such "extra services" items and prior to purchase of any chargeable materials.

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- C. Such work may include replacement of dead plant materials other than what is already covered under the warranty period, major repairs of irrigation system, by-products of vandalism or other contracts or other site related work.
 - D. Application of pre/post emergents.
 - E. Authorized extra services work must be summarized weekly and submitted with receipts to the Owner's representative.
 - F. The Owner's representative is not bound by the specifications or contract to utilize the landscape maintenance contractor in the performance of "extra services" work.
 - G. The landscape maintenance contractor shall coordinate his activities with other contractors on the site so as to not hinder the performance of any work.
 - H. Authorized charges for extra work will be paid per the General Conditions of the Contract.

1.4 SUBSTITUTIONS:

- A. Specific reference to manufacturer's names and products specified in this Section are used as standards, but this implies no right to substitute other material or methods without written approval of the Owner's representative. Such permission must be secured without additional cost to Owner's representative.
- B. Installation of any approved substitution is Contractor's responsibility. Any changes required for installation of any approved substitution must be made to the satisfaction of and without additional cost to Owner's representative.

1.5 INTENT OF THE MAINTENANCE PROGRAM:

- A. It is the intent of the maintenance program is to provide the Owner's representative with a project site that is attractive in appearance and keep all plant materials and lawns in a healthy and vigorous condition.

1.6 THE CONTRACT:

- A. This Maintenance Contract is a period of THREE months. It can be terminated by either party upon thirty (30) days notice. The Contract can also be terminated with cause.

1.7 SCHEDULE:

- A. All work under this Contract shall be performed in accordance with Section 4.00.

1.8 CONTRACTORS PERFORMANCE:

- A. The Contractor shall perform all work required once per week or as often as necessary to fulfill the spirit and intent of the Contract. The workmen shall be dressed in company uniforms and all required PPE (Personal Protective Equipment), and neat in appearance, perform their work in a professional manner, keep noise to a minimum and stage their work from a location on the site out of the way of the mainstream of the users. In general, the Contractor's presence on the site shall be as inconspicuous as possible.

1.9 COMMENCEMENT OF THE MAINTENANCE PERIOD:

- A. This maintenance period shall become effective only upon execution of the Agreement by both parties.

1.10 NEGLECT AND VANDALISM:

- A. Turf, shrubs, trees or plants that are damaged or killed due to contractors operations, negligence or chemicals shall be replaced at no expense to the Owner's representative. If plant damage or death is caused by conditions beyond the contractor's control, replacement shall be at the Owner's representative's expense.
- B. Sprinklers or structures that are damaged due to the contractor's operations must be replaced by the contractor promptly. Likewise, damage to the irrigation system by others shall be corrected immediately by the contractor, at the Owner's representative's expense.
- C. All water damage, either natural or man-made, resulting from contractor's neglect shall be corrected at the contractor's expense.
- D. All damage to or thefts of landscaping and irrigation installations not caused or allowed by the contractor shall be corrected by the contractor at the Owner's expense upon receipt of written authorization to proceed.

1.12 EMERGENCIES:

- A. The Contractor shall answer emergency or complaint calls within twelve (12) hours and corrective action shall be complete within twenty-four (24) hours.
- B. The Contractor shall answer emergency calls regarding the Landscape Irrigation system failure or need of repair, and take corrective action within eight (8) hours. Such work, unless caused due to neglect on the part of the Landscape Maintenance Contractor, shall be considered "Extra Services".

1.13 JOB CONDITIONS:

- A. Contractor shall be familiar with all site conditions.

1.14 RESTRICTIONS:

- A. Do not use growth regulators or growth retardants or any chemicals that will have adverse effects on the organic fertilizers and soil conditioners utilized for this project.

PART 2 - PRODUCTS AND MACHINERY

2.1 MATERIALS:

- A. Materials listed under this Section are expressly requested for use and does not prohibit or restrict the Contractor from providing other materials not listed in order to complete the work required herein.
- B. Pre-Emergence Weed Control: Shall be Surflan A.S., Atrazine 4L or approved equal.

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- C. Post-Emergence Weed Control: Shall be Trimec Lawn Weed Killer, Sedge Hammer, Vantage, Image or approved equal.
 - D. Sufactant: Spreader Sticker shall be used with both pre and post emergence herbicides.
 - E. Herbicide: Shall be "Round Up", by Monsanto, St. Louis, Missouri.
 - F. Insecticide: Shall be "Astro Insecticide" as manufactured by FMC Corporation, Agricultural Products Group, 1735 Market Street, Philadelphia, PA 19103 (800.321.1362) or approved equal.
 - G. Fire Ant Control: Ortho Orthene Fire Ant Killer.
 - H. Fertilizer: FERTILIZERS AND NUTRIENT AMENDMENTS:
 - 1. Fertilizer: MicroLife Hybrid 20-0-5, MicroLife Ultimate 6-2-4, and MicroLife Humates Plus 0-0-4 as supplied by San Jacinto Environmental Supplies, Houston, Texas or other approved equal supplier.
Contractor shall keep all empty bags with certificates intact and submit them to the Owner's representative.
 - a. Submission of empty fertilizer bags is required to verify operation has been performed as specified.
 - 2. Humate Soil Conditioner: Vigoro modified humate, Earthgreen Menefee Humate, Humate International AG 16-35 or approved equal.
 - 3. Aerated Compost Tea: Natures Own or approved equal.
 - I. Tree Deep Feeding Fertilizer: Shall be Aerated Compost Tea with mycorrhizal fungi manufactured by Natures Own, MicroGrow or approved equal
 - J. Fungicide: Shall be "Systemic Fungicide" with Benomyl by Greenlight Products, San Antonio, Texas 78217, and/or Cleary Chemical 3336 WP "Turf and Ornamental Fungicide.
 - K. Fertilizer for annuals/perennials:

Nelson ColorStar Plus 19-13-6 with Fungicide

Foliar spray Maximum Blooms 3-8-3 Organic liquid color fertilizer
 - L. Soil Drenching Material: Shall be "Sub Due 2E", by the Agricultural Division of Ciba-Geigy Corporation, Greensboro, North Carolina 27409.
 - M. Mulch: Shall be equal to that already in use at the site. Shredded hardwood bark for groundcover areas.
 - N. Tree Stakes and Guys: Shall match those in use at the site.

2.2 MACHINERY:

- A. Machinery requirements listed under this Section are not intended to be restrictions of specific manufacturers or models unless so stated. Specific mention of manufacturers is intended as a guide to illustrate the final product of maintenance operations desired.

1. Lawn Mowers: Shall be of the rotary type in good working order, finely tuned to protect the lawn from excessive exhaust fumes. Blades shall be sharp to reduce shredding of the cut grass blades.
2. Lawn Edgers: Shall be of a rigid or flexible blade type that will produce a fine clean edge where lawns meet walkways, pavements or curbs.
3. Fertilizer Spreaders: Cyclone type spreader or equal. No visible underlapping of applications will be permitted.
4. Deep Root Feeder: Shall be the Ross type by Ross Daniels, Incorporated, Des Moines, Iowa 50265.
5. Pruning Tools: Shall be maintained in good working order, cutting edges shall be sharp. Disinfect all tools when used for the removal of diseased limbs.

PART 3 - EXECUTION

3.1 LANDSCAPE IRRIGATION SYSTEM:

1. The Contractor shall monitor and program the automatic controlling devices to proceed optimum moisture levels in all planted areas.
2. Irrigation cycles shall be set to take place prior to sunrise (usually 4:00 - 5:00 am) unless otherwise instructed by the Owner's representative, except during visits of grounds maintenance personnel; during such visits the irrigation system may be operated as desired by those personnel.
3. Do not program controllers operating on the same water meter to water during the same time period so as to prevent over-draft of water meters. Do not switch controller to "off" at any time, except as required for testing and for maintenance operations.
4. Complete sprinkler system servicing shall be performed as required to maintain sprinklers in correct operating condition, including all required labor. Monitor and inspect sprinklers once a month or upon request of the Owner's representative. This check shall include visual "inspection" of all accessible components of the irrigation system including but not limited to controllers, remote control valves, quick couplers and heads.
5. Adjust sprinklers to avoid damage to automobiles, signs and also adjust heads to keep water off the street and sidewalks. Make repairs and alterations to the sprinkling system and water lines. All sprinklers repairs such as cleaning of heads or breaks caused by the Contractor shall be the Contractor's responsibility.
6. Minor repairs: Contractor shall make necessary repairs under \$300.00 without Owner's representative's approval to maintain operation of the system.
7. Replacement materials throughout the system shall be as specified in Section 02810.

3.2 TREES MAINTENANCE:

- A. Contractor shall maintain staking and guying of trees at all times and shall be responsible for any damage to trees or plant materials caused by chafing or breakage of foliage or limbs coming in

contact with stakes or ties. Replace broken plant stakes and ties and bent stakes as needed. If ties are too tight, they must be replaced or adjusted. If stakes are not needed, remove.

- B. Trees that may require guys, stakes or special care during the winter winds and rains shall receive the required care prior to the time of rains and high winds to insure that no damage results to the plant material.
- C. All suckers shall be continually removed from trees.

3.3 SEASONAL AND PERENNIAL FLOWERS:

- A. The maintenance contractor shall continually maintain seasonal flower beds in all contract areas.
- B. Complete weeding, trimming, edging ,and cultivation of all flower beds as required to keep the beds free of weeds, to promote growth and maintain neat, orderly appearance. As flowers cover open soil, cultivating shall be discontinued.
- C. Maintenance shall include:
 - 1. Pinching of blooms and pruning of dead or damaged foliage.
 - 2. Fertilize in alternate months with organic fertilizer. (RE: PART 2)
 - 3. Apply supplemental organic fertilizer to keep each type of seasonal flower performing at its optimum level.
 - 4. Spraying or dusting for disease or insect control as a preventive or corrective measure.
 - 5. Seasonal Color Change out: seasonal color change out after the initial planting (Extra Service) by the installing contractor.
- D. Fertilizer for annuals/perennials: Add ColorStar Plus 19-13-6 with Fungicide at the manufacturers recommended rate and feeding schedule.
Foliar spray Maximum Blooms 3-8-3 Organic liquid color fertilizer (6 ounces per 1000 sq ft) & Garlic Oil (1 ounce per 1000 sq ft) mixed together with water and sprayed every 30 days.

3.4 HEDGE MAINTENANCE:

- A. Edge, weed, fertilize and cultivate all hedge beds in accordance with Schedule.
- B. Pruning of shrubs should create a uniformly dense plant, trapezoid in shape. Height as approved by Owner's representative. Selectively thin and tip back annually. Prune to enhance natural branching effect of plants. Do not change shape of shrubs by pruning.

3.5 GROUNDCOVER BEDS:

- A. Complete weeding, trimming, edging, and cultivating of all groundcover as required to keep the beds free of weeds, to promote growth and maintain neat, orderly appearance. As groundcovers cover open soil, cultivating shall be discontinued.
- B. Groundcover beds bordering on paved surfaces must be edged as needed to retain a neat edge. Do not trim vertically so as to expose stems and thatch.
- C. Fertilize all groundcovers with complete commercial fertilizer four times per year. (Extra Service)

- D. Replant all damaged or thin areas in groundcover beds at direction of the Owner's representative, at proper spacing.
- E. Slopes of 2:1 ratio, or steeper, shall not be cultivated due to erosion nuisance, unless otherwise instructed to cultivate by the Owner's representative.

3.6 TURF MAINTENANCE:

- A. Mowing: During periods of mild weather, mow at one and one-half (1 1/2") inches but during hot weather, the cut should be not lower than two (2") inches from the soil. Regular weekly mowing is required. Never scalp the lawn or cut more than one half the existing top growth in one mowing. Remove or catch the clippings, never allowing clippings to remain on lawn surface more than four (4) hours.

Allow grass to grow up to but not over sprinkler heads. Trim grass around heads with a circular sprinkler head trimmer. DO NOT USE LINE TRIM AROUND SPRINKLER HEADS.

- B. Watering: Provide a regular, deep watering program. The established turf should not be kept wet but should dry out somewhat between waterings. A twice weekly watering is good under regular conditions, but if it is hot or windy, water more often. In very hot weather, a fast watering with fine spray will cool the turf zone and can supplement the regular, deeper watering program. In shaded areas caused by trees or shrubs, water more frequently because of the competition for soil moisture. If lawn wilts (shows grey-brown) water more frequently.
- C. Lawn Fertilizer: Analysis based upon soil sample.

March 1	MicroLife Hybird 20-0-5 applied at manufacturer's maximum recommended rate.
May 25	MicroLife Humates Plus 0-0-4 at manufacturer's maximum recommended rate.
July 18	Same as the March application.
October 11	MicroLife (6-2-4) at manufacturer's maximum recommended rate.

- D. Weed Control: Contractor shall use extreme care in the use of chemicals for weed control. Before such applications are made, the turf should be well established and in a vigorous condition. Broadleaf weeds such as malva, dandelion and plantain can be controlled with applications of selective and recommended herbicides. Always follow label directions fully and carefully; wash sprayer carefully after using herbicides.
- E. Insects: Control insects with regular applications of commercial insecticides at the manufacturer's recommended rate. Spray for insects once a month from mid-spring through summer as a preventative measure.
- F. Diseases: When they first appear, spray for diseases with an approved commercial fungicide strictly according to the manufacturer's recommendations.

3.7 GRASSES MAINTENANCE

- A. Ornamental grasses – One time per year on or about March 1st.
- B. Native grass mix - One time per year on or about March 1st.
- C. Above grasses shall be mowed to a six (6") inch height.

3.8 CONTROL OF NOXIOUS WEEDS (Johnson Grass, Nut Grass, Poison Ivy, and other Noxious Weeds.)

- A. Noxious weeds shall be killed by using "Round Up" or other spray as approved by Owner's representative. Spray only foliage of grass to be eradicated, as this spray will kill any plant that it contacts.
- B. Irrigation to sprayed area should remain "off" for a period of three days following spray application. Repeat spray as required to kill completely.
- C. Apply pre/post-emergent weed killer as per manufacturer's recommendation as required by the "Schedule" and approved by Client prior to application.
- D. Weeds 30 inches or taller shall be removed/eradicated in Native Grass zones.

3.9 USE OF HERBICIDES, INSECTICIDES, AND STERILANTS:

- A. The Contractor is hereby granted permission to use such herbicides, insecticides, and sterilants as it may find necessary and advantageous in its grounds maintenance activities. Herbicides, insecticides, and sterilants, must be used responsibly and in conformance with Federal, State, and Local laws and regulations. The Contractor assumes all liability for damage and/or injury resulting from accident or misuse of these products and/or equipment. The Owner's representative retains the right to prohibit the use of any herbicide, insecticide, and sterilant that he may judge to be undesirable for any reason.
- B. Products leaving an undesirable residue or odor (i.e., weed oil) shall not be used.
- C. The Owner's representative shall be notified prior to application and advised of any danger associated with the use of these products (i.e., to avoid personal contact with sprayed areas, etc.).
- D. Apply insecticides as needed to protect all plant materials from damage. The insect control program shall include slugs and snails and advance preventive spraying for twig borers. The Contractor shall be responsible for the choosing of chemicals and insecticides he uses and shall be accountable for any misuse of same.
- E. Apply the proper fungicide, herbicide and pesticides for the control of pests, weeds and plant diseases or treat cuts on exposed surfaces of trees or shrubs for disease and pest control on turf, plants and trees.

3.10 GENERAL CLEAN UP:

- A. The Contractor shall dispose of all waste materials or refuse from his operations legally off the property except where agreement is reached with the Owner's representative.

- B. All plant growth shall be prevented in any cracks in walks or within paved areas.
- C. Leaves, papers, grass clippings or other debris shall be removed at least weekly or at each visit from all areas.
- D. Trash receptacles shall be checked regularly and emptied and trash removed from the site frequently enough so that trash never overflows the receptacles. Trash receptacles shall be lined with black plastic bags which shall be emptied and removed from the site daily.

PART 4.00 - SCHEDULE

4.1 SCHEDULE:

The Schedule as included herein shall govern the work. Should the Contractor require an alteration of the Schedule, contact the Owner's representative.

JANUARY: WEEKS 1, 2, 3, 4

TURF

The turf shall be watered as needed. Turf shall be raked during the latter part of the month, to remove thatch. Mow turf for the first time in week 4.

TREES, SHRUBS, AND VINES

Trees shall be pruned except flowering trees and flowering shrubs which shall be pruned after flowering. Do not change shape of tree, prune to enhance shape. Pre-emergent herbicides shall be applied if approved by Client. Weed beds as required.

FEBRUARY: WEEKS 1, 2, 3, 4

TURF

The turf shall be watered as needed. Turf shall be raked during the latter part of the month, to remove thatch. Mow turf weeks 2 and 4.

TREES, SHRUBS, AND VINES

Continue pruning trees. Apply tree fertilizer to established trees. Deep root feeding is method to use during this period. Iron and other elements shall be applied if needed. Fertilize acid loving plants as called out under "Material Used". Do not fertilize flowering shrubs until blooming is completed.

MARCH: WEEKS 1,2

TURF

Turf shall be mowed in week two. Mowing shall not remove more than one-quarter (1/4") inch off existing height. First application of fertilizer (Microlife Hybrid 20-0-5) shall be applied at manufacturer's maximum recommended rate. Water thoroughly after applying fertilizer. Mow first; then fertilize.

NATIVE GRASSES

Native grasses and ornamental grasses shall be mowed.

TREES, SHRUBS, AND VINES

Check Plants for adequate watering to prevent any winter damage. Water if necessary. Prune dead wood as required. Continue to weed beds.

Mulch shall be placed in all beds, a two (2") inch to three (3") inch layer over existing mulch if mulch is not adequate. Dead vines should be removed. Flowering plants should be fertilized only after blooming.

MARCH: WEEKS 3, 4

TURF

Mow as required; still only one-quarter (1/4") inch off existing growth. Water as required. Weed control should be continued. Replace any winter damaged sod at this time.

TREES, SHRUBS, AND VINES

Inspect evergreens for insects and diseases, spray as required. Spray for borers. Continue to weed beds. Fertilize trees and flowering shrubs if they have buds.

Application should be 10-8-4 at a rate of ten (10) pounds per 1,000 square feet. Acid loving plants should be given special attention as called out in "Material Used".

APRIL: WEEKS 1, 2, 3, 4

TURF

Mowing should be continued; begin cutting one and one-half (1 1/2") inches to two (2") inches above grade. Water as required.

TREES, SHRUBS, AND VINES

Flowering plants should be through flowering and ready to be pruned and fertilized, if not already completed. Prune remaining dead wood from trees, shrubs, and vines, retaining natural shape. Continually remove all suckers on base of trees.

MAY: WEEKS 1, 2

TURF

Mowing shall continue once a week. During this period, it is important to note the soil moisture. Grasses may have been actively growing for about two and one-half (2 1/2) months, and need to be watered thoroughly.

TREES, SHRUBS, AND VINES

Inspect evergreens for mites and borers and spray as required. Inspect plants for scale insects and spray as required. Inspect flowering trees for powdery mildew and apply fungicide as required. Apply herbicide to shrub beds as required, using the same materials as in early spring. Weed beds as required. Water established trees at a rate of two (2") inches per week.

MAY: WEEKS 3, 4

TURF

Mow as required. Second application of fertilizer (Microlife Humates 0-0-4) shall be applied at manufacturer's maximum recommended rate. Water thoroughly after applying fertilizer. Mow first; then fertilize. Particular attention shall be directed to the amount of water applied to turf.

TREES, SHRUBS, AND VINES

Continue to check plants for pests and control as required. Water any established plants as needed. Pruning shall cease until Fall. Apply fertilizer to acid loving plants again.

JUNE: WEEKS 1, 2, 3, 4

Mulching trees, shrubs, groundcovers and seasonal color.

TURF

Mowing shall continue once per week. As the temperature rises, the mower should be raised one-half (1/2") inch to one (1") inch higher to maintain a good thick stand of grass. Inspect lawn for disease and inspect pests; apply fungicide only if necessary. Be alert for brown patch, Bermuda decline and chinch bugs in Bermuda sod. Watch Bermuda for bare spots and underwatered areas.

TREES, SHRUBS, AND VINES

Maintain adequate moisture for newly planted trees, shrubs, and vines. Water any established plants as needed. Do not fertilize any wood plants until cooler weather. Continue to check plants for pests and control as required. Weed beds as required.

JULY: WEEKS 1, 2, 3, 4

TURF

Mow weekly, maintain previous months height. Avoid watering in the middle of the day. Check turf for disease again, especially chinch bugs. Third application of fertilizer (Microlife Hybrid 20-0-5) should be applied at manufacturer's maximum recommended rate. Apply recommended controls as necessary.

TREES, SHRUBS, AND VINES

Maintain adequate moisture for newly planted trees, shrubs, and vines. Water any established plants as needed. Do not fertilize any woody plants until cooler weather. Continue to check plants for pests and control as required. Weed beds as required.

AUGUST: WEEKS 1, 2, 3, 4

TURF

Mow weekly. Continue to irrigate as needed to keep turf from being stressed by lack of water. Inspect lawn for diseases. Apply necessary chemicals if needed; use caution.

TREES, SHRUBS, AND VINES

Continue to check trees, shrubs, and vines for adequate moisture around rootballs. No pruning shall be done during this period. Check all trees, shrubs, and vines for possible disease and insects, spray if necessary. Second application of fertilizer should be spread at manufacturer's maximum recommended rate.

SEPTEMBER: WEEKS 1, 2

TURF

Mow weekly. At this time lower mower to one and one-quarter (1 1/4") inches to one and one-half (1 1/2") inches. Irrigate as needed.

TREES, SHRUBS, AND VINES

Maintain adequate moisture for newly planted trees, shrubs, and vines. Water any established plants as needed. Root feed trees again. Acid type fertilizer and iron should be applied to trees, shrubs, and vines.

SEPTEMBER: WEEKS 3, 4

TURF

Mow weekly. Watch turf for diseases, apply chemicals as required.

TREES, SHRUBS, AND VINES

Maintain adequate soil moisture for all trees, shrubs, and vines. Prune only if necessary. Continue to check for any pests or disease, apply chemicals as required.

OCTOBER: WEEKS 1, 2, 3, 4

TURF

Mow weeks 1, 2 and 4. Watering can be reduced at this time. Continue to check for diseases. Fourth application of fertilizer (MicroLife 6-2-4) shall be applied at manufacturer's maximum recommended rate. Mow first; then fertilize. Water thoroughly after applying fertilizer. Turf should be thick and healthy for winter months. Overseed with annual rye grass at the rate of four (4) pounds per 1,000 square feet (only if requested by the Owner).

TREES, SHRUBS, AND VINES

Check trees for proper fertilization. Apply necessary elements, if inadequate. Pruning can be started lightly at this time. Weed beds as required. A two (2") inch layer of mulch shall be added on top of existing mulch.

NOVEMBER: WEEKS 1, 2, 3, 4

TURF

Mow weeks 2 and 4. Water less at this time.

TREES, SHRUBS, AND VINES

Examine plants for pests and spray as required. Do not use pesticides unless necessary. Weed beds as required.

DECEMBER: WEEKS 1, 2, 3, 4

TURF

Last mowing shall be performed during first 2nd week of month. Rake leaves as required.

TREES, SHRUBS, AND VINES

Remove leaves from beds. Weed beds as required. Check plants for diseases, spray as required.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes transplanting non-nursery-grown trees digging and boxing.
- B. Related Requirements:
 - 1. Section 015639 "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
 - 2. Section 329300 "Plants" for new trees from nursery-grown sources.
 - 3. Section 329400 "Landscape Maintenance".

1.3 DEFINITIONS

- A. General: See definitions in ANSI A300 (Part 6) and in ANSI Z60.1 pertaining to field-grown trees, except as otherwise defined in this Section.
- B. Caliper (DBH): Diameter breast height; diameter of a trunk as measured by a diameter tape and or the average of the smallest and largest diameters at a height **54 inches (1372 mm)** above the ground line for trees with caliper of **8 inches (200 mm)** or greater as measured at a height of **12 inches (300 mm)** above the root flair.
- C. Root-Ball Depth: Measured from bottom of trunk flare to the bottom of root ball.
- D. Root-Ball Width: Measured horizontally across the root ball with an approximately circular form or the least dimension for non-round root balls, not necessarily centered on the tree trunk but within tolerance according to ANSI Z60.1.
- E. Root Flare: Also called "trunk flare." The area at the base of the tree's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to transplanting work include, but are not limited to, the following:

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- a. Construction schedule. Verify availability of materials, personnel, equipment, and unimpeded access needed to make progress and avoid delays.
 - b. Tree and plant protection.
 - c. Tree maintenance.
 - d. Arborist's responsibilities.
 - e. Landscape Architect's expectations.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For each of the following:
 1. Weed-control barriers.
 2. Proprietary Root-Ball-Stabilization Device: One unit.
 3. Slow-Release Watering Device: One unit of each size required.
- C. Pruning Schedule: Written schedule prepared by arborist detailing scope and extent of pruning each tree in preparation for and subsequent to transplanting.
 1. Species by scientific name and size of plant.
 2. Location on site plan. Include unique identifier for each.
 3. Reason for pruning.
 4. Seasonal limitations on pruning.
 5. Preparatory Pruning: Time schedule and description of preparatory pruning to be performed.
 - a. Indicate time in months preceding the extraction of the tree.
 - b. Indicate diameter of root ball and depth of root pruning for each tree.
 6. Description of root and crown pruning during and subsequent to transplanting.
 7. Description of maintenance following pruning.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified tree-service firm and arborist.
- B. Certification: From arborist, certifying that transplanted trees have been protected during construction and that trees were promptly and properly treated and repaired when damaged.
- C. Maintenance Recommendations: From arborist, recommended procedures to be established by Owner for care and protection of trees after completing the Work.
 1. Submit before completing the Work.
- D. Existing Conditions: Documentation of existing trees indicated to be transplanted, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.
 1. Use sufficiently detailed color photographs or video recordings. Color shall accurately depict hue condition of foliage and bark.

2. Include drawings and notations to indicate specific wounds and damage conditions of each tree designated to be transplanted.

E. Tree-Transplanting Program: Submit before work begins.

F. Sample Warranties: For special warranties.

G. Tree-maintenance reports.

1.7 QUALITY ASSURANCE

A. Tree-Service Firm Qualifications: An experienced landscaping contractor or tree-moving firm that has successfully completed transplanting work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.

1. Arborist Qualifications: Certified Arborist as certified by ISA Certified Arborist-Municipal Specialist as certified by ISA.

B. Tree-Transplanting Program: Prepare a written plan by arborist for transplanting trees for the whole Project, including each phase or process, tree maintenance, and protection of surrounding materials during operations. Describe in detail the materials, methods, and equipment to be used for each phase of the transplanting work.

1. Include transplanting times appropriate for each species at the Project location unless otherwise indicated on Drawing and as directed by arborist.

2. Include a transplanting schedule for each species to be transplanted, coordinated with the Project schedule.

3. Include site plans clearly marked to show tree-moving routes from extraction to planting locations. Indicate proposed equipment, weight, and turning radii.

4. Show details of temporary protective barriers where needed.

5. Include diagrams showing clearances to utility lines and other encumbrances along route.

6. Include care and maintenance provisions and eventual removal of tree stabilization.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or trees.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

3. Accompany each delivery with appropriate certificates.

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- C. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees in such a manner as to destroy their natural shape.
 - D. Completely cover foliage when transporting trees while they are in foliage.
 - E. Handle trees by root ball. Do not drop trees.
 - F. Move trees after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after moving, set trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1.9 FIELD CONDITIONS

- A. Field Measurements: Verify final grade elevations and final locations of trees and construction contiguous with trees by field measurements before proceeding with transplanting work. Perform transplanting only after finish grades are established.
- B. Weather Limitations: Proceed with transplanting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Do not transplant during excessively wet or frozen conditions. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.
- C. Coordination with Planting Areas: Perform transplanting before planting bedded areas unless otherwise indicated.
 - 1. When transplanting after planting bedded areas, protect plants, and promptly repair damage caused by transplanting operations.

1.10 WARRANTY

- A. Installer's Special Warranty: Tree-service firm agrees to repair or replace trees and related materials that fail within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's control.
 - b. Structural failures including trees falling or blowing over.
 - c. Faulty performance of materials and devices related to tree plantings including tree stabilization and watering devices.
 - 2. Warranty Periods from Date of Substantial Completion:
 - a. Trees: 18 months.
 - 3. Include the following remedial actions as a minimum:

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- a. Remove dead trees and trees with unsatisfactory growth at end of warranty period; replace when directed.
 - b. A limit of one replacement of each tree will be required except for losses or replacements due to failure to comply with requirements.
 - c. Replace materials and devices related to tree plantings.
 - d. Provide extended warranty for period equal to original warranty period, for replaced trees.

1.11 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Provide tree maintenance by skilled employees of tree-service firm and as required in Part 3. Begin maintenance immediately after preparatory pruning and continue until plantings are healthy and well established but for not less than maintenance period below.
 1. Maintenance Period: 12 months from date of transplanting completion.
- B. Continuing Maintenance Proposal: From tree-service firm 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Transplanted trees shall be healthy and resume vigorous growth within two years of transplanting without dieback due to defective extracting, handling, planting, maintenance, or other defects in the Work.

2.2 PLANTING MATERIALS

- A. Backfill Soil: Excavated soil mixed with planting soil of suitable moisture content and granular texture for placing and compacting in planting pit around tree, and free of stones, roots, plants, sod, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth.
 1. Mixture: Well-blended mix of two parts excavated soil to one part planting soil.
 2. Planting Soil: Planting soil as specified in Section 329113 "Soil Preparation."

2.3 TREE-STABILIZATION MATERIALS

- A. Trunk-Stabilization Materials:
 1. Proprietary Root-Ball-Stabilization Devices: Proprietary at- or below-grade stabilization systems to secure each new planting by root ball; sized according to manufacturer's written instructions unless otherwise indicated.
 - a. As determined by the tree moving service and approved by the Landscape Architect.

2.4 WATERING DEVICES

- A. Slow-Release Watering Device: Standard product manufactured for drip-irrigation of plants and emptying its water contents over a period of 2 to 9 hours; manufactured from UV-light stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.
- a. As determined by the tree moving service and approved by the Landscape Architect.

2.5 MISCELLANEOUS PRODUCTS

- A. Organic Mulch: Shredded hardwood as specified in Section 329300 "Plants."
- B. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.
- C. Burlap: Non-synthetic, biodegradable.
- D. Pesticides: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended in writing by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
1. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
2. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.
- E. Planting Tablets: Tightly compressed chip type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
1. Size: 21-gram tablets.
2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.
- F. Weed-Control Barriers:
1. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. (101 g/sq. m) minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.
- G. Wood Preservative Treatment by Pressure Process: AWWA U1; Use Category UC4a, using preservative chemicals acceptable to authorities having jurisdiction and containing no arsenic or chromium.

PART 3 - EXECUTION

3.1 TREE-TRANSPLANTING SPECIALIST

- A. Tree-Transplanting Specialist Firms: Subject to compliance with requirements, have tree transplanting performed by one of the following firms:
1. Environmental Design, (800) 376-4260, www.treemover.com.

3.2 EXAMINATION

- A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross transplanting areas.
- B. For the record, prepare written report, endorsed by arborist, listing conditions detrimental to transplanting work and tree protection and health.
- C. Proceed with transplanting only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, other facilities, turf areas, and other plants and planting areas from damage caused by transplanting operations.
- B. Locate and clearly identify trees for transplanting. Red striped flagging tape each tree at **54 inches (1372 mm)** above the ground.
- C. Lay out individual transplant locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before transplanting. Make minor adjustments as required.
- D. Apply antidesiccant to trees uniformly, using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during extracting, handling, and transportation.
1. If deciduous trees are moved in full leaf, spray with antidesiccant before extracting and again two weeks after transplanting.
- E. Wrap trees with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during extracting, handling, and transporting.

3.4 PREPARATORY PRUNING

- A. Root Pruning: Perform preparatory root pruning under direction of arborist as far in advance of extracting each tree as the Project Schedule allows.
1. Dig exploratory pits or trench by hand or with air spade around perimeter of tree at indicated root-ball width to determine locations of main lateral roots.

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2. Dig trench by hand or with tree spade around perimeter of tree at indicated root-ball width to the depth of the root system. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
 3. Root-Ball Width: Minimum **9 inches** of root-ball diameter, or least dimension for non-round root balls, for each **inch (25 mm)** of tree caliper being transplanted.
 4. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking.
 5. Use narrow-tine spading forks to comb soil to expose roots with minimal damage to root system.
 6. Cut exposed roots manually with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
 7. Do not paint or apply sealants on cut root ends.
 8. Backfill trench with excavated soil.

B. Crown Pruning (Tip Pruning):

1. Perform preparatory crown pruning under direction of arborist. Follow procedures as specified in "Crown Pruning" Article.

3.5 EXCAVATING PLANTING PITS

A. General: Excavate under supervision of the arborist.

1. Excavate planting pits or trenches with sides sloping. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil. Scarify sides of planting pit smeared or smoothed during excavation.
2. Excavate approximately two times as wide as root ball.
3. Keep excavations covered or otherwise protected until replanting trees.

B. Subsoil and topsoil removed from excavations may be used as planting soil.

C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees are encountered in excavations.

1. Hardpan Layer: Drill **6-inch- (150-mm-)** diameter holes, **24 inches (600 mm)** apart, into free-draining strata or to a depth of **10 feet (3 m)**, whichever is less, and backfill with free-draining material.

D. Seepage: Notify Architect if subsoil conditions evidence unexpected water seepage into tree-planting pits.

E. Drainage: Fill planting pit or trench with **6 inches (152 mm)** of water and time the infiltration rate of the soil. If the drainage rate is less than **0.25 inch (6 mm)** per hour, notify Architect to determine need for subsurface drainage.

3.6 EXTRACTING TREES

A. General: Extract trees under supervision of the arborist.

B. Orientation Marking: Mark the north side of each tree with non-permanent paint before extracting.

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- C. Root-Ball Width: Minimum **10 inches (250 mm)** of root-ball diameter, or least dimension for non-round root balls, for each **inch (25 mm)** of tree caliper being transplanted.
 - 1. Out-of-Season Planting: If planting before or after the in-season period for tree, provide a minimum root-ball diameter of **12 inches (305 mm)** each **inch (25 mm)** of tree caliper being transplanted.
 - D. Root-Ball Depth: As determined by the arborist for each species and size of tree and for site conditions at original and planting locations.
 - E. Digging:
 - 1. Dig and clear a pit [by hand] [or] [with tree spade] to the depth of the root system. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
 - 2. Use narrow-tine spading forks to comb soil to expose roots with minimal damage to root system.
 - 3. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking.
 - 4. Cut exposed roots manually with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not paint or apply sealants on cut root ends.
 - 5. Construct box tight against root system sides and bottom as pit is dug. Brace and support box to prevent breaking of root ball.
 - 6. Temporarily support and protect exposed roots from damage until they are permanently redirected and covered with soil. Cover roots with burlap and keep them moist until planted.

3.7 PLANTING

- A. Planting Standard: Perform planting according to ANSI A300 (Part 6) unless otherwise indicated.
- B. Before planting, verify that root flare is visible at top of root ball. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- C. Ensure that root flare is visible after planting.
- D. Remove injured roots by cutting cleanly; do not break. Do not paint or apply sealants on cut root ends.
- E. Orientation: Position the tree so that its north side, marked before extracting, is facing north in its new location.
- F. Set tree plumb and in center of planting pit with top of root flare **2 inches (50 mm)** above adjacent finish grades.
 - 1. Use specified backfill soil for backfill.
 - 2. If area under the tree was initially dug too deep, add backfill to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
 - 3. After placing some backfill around root ball to stabilize plant, begin backfilling.
 - 4. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.

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5. Redirect exposed root ends downward in backfill areas where possible. Hand-expose roots as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately **3 inches (75 mm)** back from new construction and as required for root pruning.
 6. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended by arborist. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
 7. Continue backfilling process. Water again after placing and tamping final layer of soil.
- G. Slopes: When planting on slopes, set the tree so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.8 CROWN PRUNING

- A. Prune branches under direction of arborist.
1. Prune to remove only broken, dying, or dead branches. Do not prune for shape.
 2. Do not remove or reduce living branches to compensate for root loss caused by cutting root system or to improve natural tree form.
 3. Pruning Standards: Perform pruning according to ANSI A300 (Part 1).
- B. Unless otherwise directed by arborist and acceptable to Architect, do not cut tree leaders.
- C. Cut branches with sharp pruning instruments; do not break or chop.
- D. Do not paint or apply sealants to wounds.
- E. Provide subsequent maintenance during Contract period as recommended by arborist.
- F. Chip removed branches and spread over areas identified by Landscape Architect.

3.9 TREE STABILIZATION

1. Proprietary Root-Ball-Stabilization Device: Install root-ball-stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

3.10 MULCHING

- A. Organic Mulch: Apply **3-inch (75-mm)** average thickness of organic mulch extending **12 inches (300 mm)** over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within **6 inches (150 mm)** of trunks or stems.

3.11 INSTALLING SLOW-RELEASE WATERING DEVICE

- A. Provide as many devices as required for each tree.

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- B. Place device on top of the mulch at base of tree and fill with water according to manufacturer's written instructions.

3.12 TREE MAINTENANCE

- A. Perform tree maintenance as recommended by arborist. Maintain arborist observation of transplanting work.
- B. Maintain trees by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Treat as required to keep trees free of insects and disease.
- C. From time of preparatory root pruning measure soil moisture adjacent to edge of each root ball weekly. Record findings and weather conditions.
- D. Fill areas of soil subsidence with backfill soil. Replenish mulch materials damaged or lost in areas of subsidence.
- E. Apply treatments as required to keep tree materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.
- F. Pesticide Application: Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written instructions. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
 - 1. Pre-Emergent Herbicides (Selective and Non-Selective): Apply in accordance with manufacturer's written instructions. Do not apply to seeded areas.
 - 2. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written instructions.
- G. Reports: Have arborist prepare monthly inspection reports.

3.13 REPAIR AND REPLACEMENT

- A. General: Repair or replace transplanted trees and other plants indicated to remain or be relocated that are damaged by construction operations, in a manner recommended by the arborist and approved by Architect.
 - 1. Submit details of proposed pruning and repairs.
 - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours according to arborist's written instructions.
 - 3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.

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- B. Remove and replace trees that are more than 25 percent dead or in an unhealthy condition or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.
 - 1. Provide new trees of similar size as those being replaced for each tree of 6 inches (150 mm) or smaller in caliper size.

3.14 CLEANUP AND PROTECTION

- A. During transplanting, keep adjacent paving and construction clean and work area in an orderly condition.
- B. Protect trees from damage due to transplanting operations and operations of other contractors and trades. Maintain protection during transplanting and maintenance periods. Treat, repair, or replace damaged plantings.
- C. After planting and before Substantial Completion, remove tags, markings, tie tape, labels, wire, burlap, and other debris from transplanted trees, planting areas, and Project site.

3.15 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Except for materials indicated to be recycled, remove surplus soil, excess excavated material, waste materials, displaced plants, trash, and debris, and legally dispose of them off Owner's property.
- B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.
 - 1. Except for materials indicated to be retained on Owner's property or recycled, remove excess excavated material, waste materials, displaced plants, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 329600

DIVISION 33

Utilites

95% Construction Documents

SECTION 0331000 – WATER UTILITIES

PART 1 – GENERAL

1.1 SUMMARY

- A. This section includes materials and procedures for the construction of underground water distribution systems for potable and fire protection water, in accordance with SAWS standards.

1.2 RELATED DOCUMENTS

- A. Section 312000 – Earth Moving
- B. Section 033000 – Cast-in-Place Concrete
- C. SAWS Standard Specifications and Drawings
- D. SAWS Utility Service Regulations

1.3 REFERENCES

- A. SAWS Construction Specifications
- B. SAWS Approved Product List
- C. ASTM, AWWA, NFS, and TCEQ standards

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Product data and shop drawings per SAWS submittal requirements
- B. Certifications (NSF 61, NSF 372)
- C. SAWS Product Submittal Application (if applicable)
- D. Test reports and as-built drawings

1.5 QUALITY ASSURANCE

- A. All materials and workmanship must comply with SAWS Construction & Material Specifications
- B. Use only products from the SAWS Approved Products List
- C. Contractor must coordinate with SAWS for inspections and approvals

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials per SAWS guidelines
- B. Protect from contamination and damage
- C. Maintain end caps on pipes

PART 2 – PRODUCTS

2.1 PIPING MATERIALS

- A. Store materials per SAWS guidelines
- B. Protect from contamination and damage
- C. Maintain end caps on pipes

2.2 VALVES AND HYDRANTS

- A. Gate Valves: Resilient wedge, AWWA C509/C515
- B. Butterfly Valves: AWWA C504
- C. Fire Hydrants: SAWS-approved, AWWA C502

2.3 FITTINGS AND RESTRAINTS

- A. Mechanical joint fittings: AWWA C110/C153
- B. Thrust blocks: Per SAWS standard drawings

- C. Restrained joint systems: Megalug or SAWS-approved equal

2.4 ACCESSORIES

- A. Tracer wire: 12 AWG solid copper with HDPE jacket
- B. Valve boxes and covers: Cast iron, traffic-rated, SAWS-approved

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install per SAWS Construction Specifications
- B. Maintain minimum cover and separation distances
- C. Proper bedding and backfill per SAWS standards

3.2 CONNECTIONS

- A. Coordinate with SAWS for all tie-ins
- B. Use approved transition fittings
- C. Submit tie-in request forms as required

3.3 TESTING AND DISINFECTION

- A. Hydrostatic testing: 150 psi for 2 hours
- B. Leakage testing per AWWA C600/C605
- C. Disinfection per AWWA C651 and SAWS procedures
- D. All testing must be witnessed and approved by SAWS

3.4 CLEANING AND RESTORATION

- A. Restore all disturbed areas to original or better condition
- B. Submit as-built drawings to SAWS

END OF SECTION

SECTION 0331001 – WATER UTILITIES

PART 1 – GENERAL

1.1 SUMMARY

- A. This section includes materials and procedures for the construction of underground water distribution systems for potable and fire protection water, in accordance with SAWS standards.

1.2 RELATED DOCUMENTS

- A. Section 312000 – Earth Moving
- B. Section 033000 – Cast-in-Place Concrete
- C. SAWS Standard Specifications and Drawings
- D. SAWS Utility Service Regulations

1.3 REFERENCES

- A. SAWS Construction Specifications
- B. SAWS Approved Product List
- C. ASTM, AWWA, NFS, and TCEQ standards

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Product data and shop drawings per SAWS submittal requirements
- B. Certifications (NSF 61, NSF 372)
- C. SAWS Product Submittal Application (if applicable)
- D. Test reports and as-built drawings

1.5 QUALITY ASSURANCE

- A. All materials and workmanship must comply with SAWS Construction & Material Specifications
- B. Use only products from the SAWS Approved Products List
- C. Contractor must coordinate with SAWS for inspections and approvals

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials per SAWS guidelines
- B. Protect from contamination and damage
- C. Maintain end caps on pipes

PART 2 – PRODUCTS

2.1 PIPING MATERIALS

- A. Store materials per SAWS guidelines
- B. Protect from contamination and damage
- C. Maintain end caps on pipes

2.2 VALVES AND HYDRANTS

- A. Gate Valves: Resilient wedge, AWWA C509/C515
- B. Butterfly Valves: AWWA C504
- C. Fire Hydrants: SAWS-approved, AWWA C502

2.3 FITTINGS AND RESTRAINTS

- A. Mechanical joint fittings: AWWA C110/C153
- B. Thrust blocks: Per SAWS standard drawings

- C. Restrained joint systems: Megalug or SAWS-approved equal

2.4 ACCESSORIES

- A. Tracer wire: 12 AWG solid copper with HDPE jacket
- B. Valve boxes and covers: Cast iron, traffic-rated, SAWS-approved

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install per SAWS Construction Specifications
- B. Maintain minimum cover and separation distances
- C. Proper bedding and backfill per SAWS standards

3.2 CONNECTIONS

- A. Coordinate with SAWS for all tie-ins
- B. Use approved transition fittings
- C. Submit tie-in request forms as required

3.3 TESTING AND DISINFECTION

- A. Hydrostatic testing: 150 psi for 2 hours
- B. Leakage testing per AWWA C600/C605
- C. Disinfection per AWWA C651 and SAWS procedures
- D. All testing must be witnessed and approved by SAWS

3.4 CLEANING AND RESTORATION

- A. Restore all disturbed areas to original or better condition
- B. Submit as-built drawings to SAWS

END OF SECTION

SECTION 0333000 – SANITARY SEWERAGE UTILITIES

PART 1 – GENERAL

1.1 SUMMARY

- A. This section includes materials, installation, and testing requirements for gravity sanitary sewer systems, including:
- B. PVC and ductile iron sewer mains
- C. Manholes and cleanouts
- D. Connections to existing systems
- E. Appurtenances per SAWS standards

1.2 RELATED DOCUMENTS

- A. Section 31 20 00 – Earth Moving
- B. Section 03 30 00 – Cast-in-Place Concrete
- C. SAWS Standard Specifications and Drawings
- D. SAWS Utility Service Regulations

1.3 REFERENCES

- A. SAWS Construction Specifications
- B. SAWS Approved Products List
- C. ASTM D3034, ASTM F679, ASTM C478
- D. AWWA, TCEQ, and City of San Antonio standards

1.4 SUBMITTALS

- A. Product data and shop drawings
- B. SAWS Product Submittal Application (if applicable)
- C. Test reports and as-built drawings
- D. Preconstruction submittals per SAWS checklist

1.5 QUALITY ASSURANCE

- A. All materials and workmanship must comply with SAWS Construction & Material Specifications
- B. Use only SAWS-approved products
- C. Contractor must coordinate with SAWS for inspections and approvals

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials per SAWS guidelines
- B. Protect from contamination and damage
- C. Maintain end caps on pipes

PART 2 – PRODUCTS

2.1 PIPING MATERIALS

- A. PVC Gravity Sewer Pipe: ASTM D3034 SDR 35 ($\leq 15"$), ASTM F679 ($\geq 18"$)
- B. Ductile Iron Pipe (DIP): AWWA C151, for deep installations or where required
- C. HDPE: Only with SAWS approval for trenchless installations

2.2 MANHOLES AND INLETS

- A. Precast Concrete Manholes: ASTM C478, with SAWS-approved coatings
- B. Covers and Frames: Cast iron, traffic-rated, marked "SAWS SEWER"
- C. Drop Connections: Per SAWS standard detail

2.3 ACCESSORIES

- A. Joint Sealants
- B. Flexible couplings: Fernco or equal, SAWS-approved
- C. Cleanouts: Per SAWS standard detail
- D. Tracer wire: Required for all non-metallic pipe

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Verify that site conditions are suitable for installation.
- B. Notify Engineer of any conditions that may adversely affect installation.

3.2 INSTALLATION

- A. Install per SAWS Construction Specifications
- B. Maintain minimum slope and cover
- C. Proper bedding and backfill per SAWS standards
- D. Use laser or GPS for alignment verification

3.3 TESTING

- A. Low-pressure air test: Per ASTM F1417
- B. Mandrel test: For deflection in flexible pipe
- C. Vacuum test: For manholes per ASTM C1244
- D. All testing must be witnessed and approved by
- E. Repair or replace defective work.

3.4 CLEANING

- A. Remove debris and excess materials from site.
- B. Restore all disturbed areas to original or better condition
- C. Submit as-built drawings to SAWS

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes sanitary sewer and appurtenances from a point 5 feet outside building lines to the point of disposal. Refer to Division 22 Sections for continuation of sanitary sewer system.

1.3 RELATED SECTIONS

- A. Section 03 30 00 – Cast-In-Place Concrete.
- B. Section 31 00 00 – Site Earthwork.
- C. Section 31 50 00 – Excavation Support and Protection.
- D. Section 33 10 00 – Water Utilities.

1.4 DEFINITIONS

- A. Building Drain – That part of the lowest piping of the drainage system that receives the discharge from soil, waste and other drainage pipes inside and that extends 30 inches in developed length of pipe beyond the exterior walls of the building and conveys the drainage to the Building Sewer.
- B. Building Sewer – That part of the drainage system that extends from the end of the Building Drain and conveys the discharge to a public sewer, private sewer, individual sewage disposal system or other point of disposal.

1.5 REFERENCES

- A. American Concrete Pipe Association (APA) 8445 Freeport Parkway, Suite 350, Irving, Texas 75063-2595. All references are to most recent edition.
 - 1. ACPA – 01-102 – Concrete Pipe Handbook.
 - 2. ACPA 01-103 – Concrete Pipe Installation Manual.
- B. ASME International (ASME) Three Park Avenue, New York, New York 10016. All references are to currently active publication.
 - 1. ASME B1.20 – Pipe Threads, General Purpose (Inch).
 - 2. ASME B16.1 – Gray Iron threaded Fittings, Classes 25, 125, and 250.
 - 3. ASME B18.2.2 – Standard for Square and Hex Nuts.
- C. American National Standards Institute (ANSI), 1819 L Street NW, Suite 600 Washington, DC 20036. All references are to current active specification.
 - 1. A21.4 – Cement Mortar Lining for Ductile Iron Pipe and Fittings.
 - 2. A21.50 – Thickness Design of Ductile Iron Pipe.
 - 3. A21.51 – Ductile Iron Pipe, Centrifugally Cast.
- D. American Society of Testing and Materials (ASTM), 1916 Race Street, Philadelphia, Pennsylvania 19103. All references shall be to current active standard.
 - 1. ASTM A47 – Standard Specification for Ferritic Malleable Iron Castings.
 - 2. ASTM A48 – Standard Specification for Gray Iron Castings.
 - 3. ASTM A74 – Standard Specification for Cast Iron Soil Pipe and Fittings.
 - 4. ASTM A123 – Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
 - 5. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - 6. ASTM A536 – Standard Specification for Ductile Iron Castings.
 - 7. ASTM A563 – Standard Specification for Carbon and Alloy Steel Nuts.

8. ASTM A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
9. ASTM A746 – Standard Specification for Ductile Iron Gravity Sewer Pipe.
10. ASTM C33 – Standard Specification for Concrete Aggregates.
11. ASTM C76 – Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
12. ASTM C94 – Standard Specification for Ready-Mixed Concrete.
13. ASTM C150 – Standard Specification for Portland Cement.
14. ASTM C260 – Standard Specification for Air Entraining Admixtures for Concrete.
15. ASTM C270 – Standard Specification for Mortar for Unit Masonry.
16. ASTM C387 – Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
17. ASTM C443 – Standard Specification for Joints for Pipes and Manholes Using Rubber Gaskets.
18. ASTM C478 – Standard Specification for Precast Reinforced Concrete Manhole Sections.
19. ASTM C564 – Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings,
20. ASTM C595 – Standard Specification for Blended Hydraulic Cements.
21. ASTM C923 – Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
22. ASTM C972 – Compression Recovery of Tape Sealant.
23. ASTM C990 – Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants.
24. ASTM D256 – Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
25. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension.
26. ASTM D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
27. ASTM D638 – Standard Test Method for Tensile Properties of Plastics.
28. ASTM D696 – Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C with a Vitreous Silica Dilatometer.
29. ASTM D746 – Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
30. ASTM D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
31. ASTM D1238 – Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
32. ASTM D1248 – Standard Specification for Polyethylene Plastics Extrusion Materials For Wire and Cable.
33. ASTM D1505 – Standard Test Method for Density of Plastics by the Density-Gradient Technique.
34. ASTM D1525 – Standard Test Method for Vicat Softening Temperature of Plastics.
35. ASTM D1693 – Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
36. ASTM D1784 – Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated (Poly Vinyl Chloride) (CPVC) Compounds.
37. ASTM D1785 – Standard Specification for Poly (Vinyl Chloride) (PVC), Plastic Pipes, Schedules 40, 80, and 120.
38. ASTM D2240 – Standard Test Method for Rubber Property—Durometer Hardness.
39. ASTM D2241 – Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR Series).
40. ASTM D2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
41. ASTM D2412 – Determination of External Loading Characteristics of Plastic Pipe by Parallel Plate Loading.

42. ASTM D2464 – Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
43. ASTM D2466 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
44. ASTM D2467 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
45. ASTM D2680 – Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
46. ASTM D2837 – Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
47. ASTM D2996 – Filament Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
48. ASTM D2997 - Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
49. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
50. ASTM D3035 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
51. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
52. ASTM D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
53. ASTM D3262 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.
54. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
55. ASTM D3753 - Standard Specification for Glass-Fiber-Reinforced Polyester Manholes and Wetwells.
56. ASTM D3840 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Fittings for Nonpressure Applications.
57. ASTM D4101 – Standard Specification for Polypropylene Injection and Extrusion Materials.
58. ASTM D4161 – Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals.
59. ASTM F402 – Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings.
60. ASTM F477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
61. ASTM F714 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.
62. ASTM F758 – Standard Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage.
63. ASTM F794 – Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
64. ASTM F949 – Standard Specification for Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings.
65. ASTM F1290 – Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings.
66. ASTM F1417 – Standard practice for Installation Acceptance of Plastic Non-Pressure Sewer Lines Using Low-Pressure Air.
67. ASTM F1473 – Standard Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins.
68. ASTM F2620 – Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.
- E. Cast Iron Soil Pipe Institute (CISPI) 1064 Delaware Avenue SE, Atlanta, Georgia 30316. All references are to most recent edition.
 1. CISPI 301 – Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.

2. CISPI 310 - Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
- F. International Code Council
 1. International Plumbing Code (IPC)
- G. Plastic Pipe Institute (PPI), 105 Decker Court, Suite 825 Irving TX, 75062.
 1. PPI TN-34 – Installation Guidelines for Electrofusion Couplings 14” and Larger.
 2. PPI TN-42 – Recommended Minimum Training Guidelines for PE Pipe Butt Fusion Joining Operators for Municipal and Industrial Projects.
 3. PPI TR-4 – PPI Listing of Hydrostatic Design Basis (HDB), Pressure Design Basis (PDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe.
 4. PPI TR-33 – Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe.
 5. PPI TR-41 – Generic Saddle Fusion Joining Procedure for Polyethylene Gas Piping.
- H. Texas Commission on Environmental Quality (TCEQ)
 1. TAC Title 30, Part 1, Chapter 217, Subchapter 217, Rule 217.57 – Testing Requirements for Installation of Gravity Collection System Pipes.
 2. TAC Title 30, Part 1, Chapter 217, Subchapter 217, Rule 217.58 – Testing requirements for Manholes.

1.6 SUBMITTALS

- A. Shop Drawings
 1. Submit drawings for the system, showing pipe sizes, locations, elevations, and slopes for horizontal runs. Include details of manholes, piping, fittings, and connections.
 2. Product Submittals.
 3. Pipe Materials.
 4. Test Reports.
- B. Certifications
 1. For manholes the manufacturer shall provide independent certification consisting of the manufacturer’s test report and accompanied by a copy of the test results that the manhole has been sampled, tested, and inspected in accordance with the provisions of ASTM D3735 and meets all requirements.
- C. Submit Record Documents (As-Builts) locating actual horizontal and vertical location of installed sanitary sewer piping, cleanouts, manholes, and related work.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Delivery and Storage
 1. Piping
 - a. Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store [plastic piping and jointing materials and] rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.
 2. Metal Items
 - a. Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials.
 3. Cement, Aggregate and Reinforcement
 - a. As specified in Section 03 30 00 Cast-In-Place Concrete.
- B. Handling
 1. Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. Take special care not to damage linings of pipe and fittings; if lining is damaged, make satisfactory repairs. Carry, do not drag, pipe to trench.
 2. Handle HDPE the pipe in accordance with the PPI Handbook of Polyethylene Pipe (2nd Edition), Chapter 2 using approved strapping and equipment rated for the loads encountered. Do not use

- chains, wire rope, forklifts or other methods or equipment that may gouge or damage the pipe or endanger persons or property.
3. If any gouges, scrapes or other damage to the pipe results in loss of 10% of the pipe wall thickness, cut out that section or do not use.
 4. Do not drop or impact fiberglass manholes. Lift manholes with two slings on spreader bar in horizontal position or by use of 4 in. x 4 in. timber inserted crosswise inside the manhole to the underside of the collar with rope or woven fabric slings attached to backhoe or other lifting device. Under no conditions shall cables or chains be put around fiberglass manholes. Do not roll fiberglass manholes when moving or during installation.

PART 2 - PRODUCTS

2.1 PIPING

- A. Polyvinyl Chloride Pipe and Fittings (Outside Building Slabs and Pavements): ASTM D3034, SDR-26, for gasketed joints. Provide elastomeric gasket seals conforming to ASTM F477.
- B. High-Density Polyethylene (HDPE) Pipe and Fittings
 1. HDPE sanitary sewer pipe and fittings shall be a minimum of SDR 17.
 2. Pipe and fittings shall be made from Extra High Molecular Weight (EHMW) high-density polyethylene with a standard thermoplastic material designation of PE3608 and having a cell classification of 345464C, D, or E when tested in accordance with ASTM D3350.
 3. The Manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDB) of 1,600 psi at 73.4 degrees F. The stress regression testing shall have been performed in accordance with ASTM D2837. Upon request, the Manufacturer shall supply certification that the materials used to manufacture the pipe and fittings meet the above requirements.
 4. The materials shall meet the following nominal physical property requirements:

Property	Test Method	Nominal Value
Material Designation	PPI/ASTM	PE4710
Cell Classification	ASTM D3350	PE445574A
Density, Natural	ASTM D792	0.946 gm/cc
Melt Index (190°C/2.16 kg)	ASTM D1238	0.10 gm/10 min.
Flow Rate (190°C/21.6 kg)	ASTM D1238	7.0 gm/10 min.
Tensile Strength @ Yield	ASTM D638	3,500 psi
Ultimate Elongation	ASTM D638	>500%
Flexural Modulus, 2% Secant	ASTM D790	152,000 psi
Resistance to Rapid Crack Propagation Pc – S-4 @ 32°F Tc – S-4 @ 145 psi	ISO 13477 ISO 13477	>174 psi <2°F
Slow Crack Growth PENT @ 2.4 MPa 176°F 194°F	ASTM F1473 ASTM F1473	>10,000 hr >10,000 hr
Brittleness Temperature	ASTM D746	<-103°F
Izod Impact Strength, Notched	ASTM D256	9.1 ft-lb/in
PPI Hydrostatic Design Basis (As listed in PPI TR-4)	ASTM D2837	1,600 psi HDB @ 73°F 800 psi HDB @ 180°F

5. Piping shall be manufactured from compounds in compliance with the above table. The dimensional and performance characteristics shall conform to the requirements of ASTM F714 for sizes 4 inch IPS and larger and to ASTM D3035 for sizes smaller than 4 inch IPS. Each lot of material shall be tested for melt index, density, and %carbon. Upon request, the Manufacturer shall furnish test data.

6. Polyethylene fabricated fittings shall be manufactured from polyethylene pipe, sheet stock or molded fittings meeting the material requirements of this specification.
 7. Polyethylene fittings, including custom fabrications, shall have the same internal pressure rating as the mating pipe. At the point of fusion, the wall thickness and outside diameter of the fitting shall be in accordance with ASTM F714 or ASTM D3035 for the same pipe size.
 8. The Manufacturer's Quality system shall be certified to be in accordance with ISO 9001:2000.
- C. Pressure Polyvinyl Chloride Pipe and Fittings (Outside Building Slabs and Pavements)
1. Pipe and Fittings Less Than 4" in Diameter:
 - a. Pipe, couplings and fittings shall be manufactured of materials in conformance with ASTM D1784, Class 12454B.
 - b. Screw-Joint: Pipe shall conform to dimensional requirements of ASTM D1785, Schedule 80, with points meeting requirements of 150 psi working pressure, 200 psi hydrostatic test pressure, unless otherwise shown or specified. Fittings for threaded pipe shall conform to requirements of ASTM D2464, threaded to conform to the requirements of ASME B1.20.1 for use with Schedule 80 pipe and fittings. Pipe couplings, when used, shall be tested as required by ASTM D2644.
 - c. Push-On Joint: ASTM D3139, with ASTM F477 gaskets. Fittings for push-on joints shall be iron conforming to AWWA C110/A21.10 or AWWA C111/A21.11. Iron fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104/A21.4.
 - D. Solvent Cement Joint: Pipe shall conform to dimensional requirements of ASTM D1785 or ASTM D2241 with joints meeting the requirements of 150 psi working pressure and 200 psi hydrostatic test pressure. Fittings for solvent cement Cast Iron Soil Piping.
 1. Cast Iron Hub and Spigot Soil Pipe and Fittings
 - a. ASTM A74 with ASTM C564 compression type rubber gaskets.
 2. Cast Iron Hubless Soil Pipe and Fittings
 - a. CISPI 301 with CISPI 310 coupling joints.
 - b. Jointing shall conform to ASTM D2466 or ASTM D2467.
 - E. Ductile Iron Pipe and Fittings
 1. Ductile Iron Pipe shall be centrifugally cast of 60-42-10 iron and shall conform to the requirements of the latest revision of ANSI A21.51/AWWA C151. Thickness or class shall be that required for laying condition type 4 or 5, in accordance with actual conditions at the site. Ductile Iron Pipe may be "thickness designed" in accordance with requirements of the latest revision of ANSI A21.50/AWWA C150. The thickness design shall be based on standard laying conditions 4 or 5 in accordance with conditions at the site. Fittings for ductile iron pipe shall have not less than the thickness, class, or pressure rating specified for ductile iron pipe. Fittings shall be furnished with all necessary glands, gaskets, bolts, etc. as may be required to complete the joints.
 2. Rubber gasket joints for mechanical joints or push on type joints shall conform to the requirements of ANSI A21/AWWA C111.
 3. All ductile iron pipe and fittings shall be cement mortar lined or polyethylene lined.
 - a. Cement mortar lining shall be in accordance with ANSI A21.4/AWWA C104.
 - b. Polyethylene lining for pipe and fittings shall be virgin polyethylene complying with ASTM D1248, compounded with inert filler and with sufficient carbon black to resist ultraviolet rays during storage of the pipe and fittings. The polyethylene shall be bonded to the interior of the pipe or fitting by heat. Polyethylene lining in pipe and in fittings shall be 40 mils nominal thickness. Minimum lining thickness shall be 30 mils.

2.2 MORTAR

- A. Masonry Mortar - ASTM C270, Type M. For minor amounts of mortar, packaged materials complying with ASTM C387, Type M will be accepted.

2.3 PORTLAND CEMENT

- A. Submit certificates of compliance stating the type of cement used in manufacture of precast manholes. Portland shall conform to ASTM C150. Type II for concrete used in precast manholes. Where aggregates are alkali reactive, as determined by Appendix XI of ASTM C33, a cement containing less than 0.60 percent alkalis shall be used.

2.4 PORTLAND CEMENT CONCRETE

- A. Ready-Mixed – meeting ASTM C94, Option A, and the following:
 - 1. Manhole Base: Minimum Compressive Strength: conforming to the requirements of ASTM C478.
 - 2. Riser:
 - a. Minimum Compressive Strength: 3,000 psi at 28 days.
 - b. Maximum Aggregate Size: 1-1/2 inches.
 - c. Slump: 2 to 4 inches.
- B. Cement shall conform to one of the following:
 - 1. ASTM C150, Type II.
 - 2. ASTM C150, Type I, limited to a maximum tricalcium aluminate (C₃A) content of 12 percent and combined with fly ash as specified herein.
 - 3. ASTM C595, Type IP blended hydraulic cement provided the cement conforms to ASTM C150 and fly ash is as specified herein.
 - 4. Minimum Portland Cement Content: 564 pounds per cubic yard for concrete without fly ash.
 - 5. Minimum Cementitious Materials (Portland Cement plus Fly Ash): 490 pounds per cubic yard for concrete with fly ash.
 - 6. Amount of Fly Ash: Minimum 15 percent, and maximum 25 percent, of the cementitious materials, unless otherwise directed by the Owner's Representative.
 - 7. Water/Cement Ratio (Cementitious Materials) Ratio: Maximum of 0.49.
- C. Fly Ash
 - 1. Provide as specified in Section 03 30 00.
- D. Mortar
 - 1. Standard premixed meeting ASTM C387, or proportion 1 part Portland cement to 2 parts clean, well-graded sand, which will pass a 1/8-inch screen.
 - 2. Admixtures may be included but do not exceed the following percentages of weight of cement:
 - a. Hydrated Lime: 10 percent.
 - b. Diatomaceous Earth or Other Inert Material: 5 percent.
 - 3. Consistency:
 - a. Tongue and Groove Type Joint: Such that mortar will readily adhere to pipe.
 - b. Confined Groove (Keylock) Joint: Such that excess mortar will be forced out of groove, the tongue will not provide support for the section being placed.
- E. Bonding Agent
 - 1. Sika Corp., Sikastix 370.
 - 2. Sika Corp., Sikador Hi-Mod.
 - 3. Horn Co., Epoxite Binder 2385.
- F. Forms
 - 1. Trench walls, large rock, or earth are not acceptable form material.
 - 2. Exposed Surface: Plywood or steel panels.
 - 3. Other Surfaces: Matched boards, plywood, or other approved material.
- G. Reinforcing Steel
 - 1. Reinforcing steel shall conform to ASTM A615, Grade 60, deformed bars.

2.5 MANHOLES

- A. Cast-In-Place Manholes
 - 1. Acceptable, subject to the Owner's Representative approval.
- B. Precast Manhole Riser Sections

1. Minimum 48 inches in diameter for sanitary sewer uses and 48 inches for storm drain uses, conforming to ASTM C478.
 2. Minimum Wall Thickness: 4 inches or 1/12 times inside diameter, whichever is greater.
 3. Provide eccentric cones for manholes. Cones shall have same wall thickness and reinforcement as riser section.
 4. First riser section shall be monolithic.
 5. Top and bottom of section shall be parallel.
 6. Confined O-ring with rubber gaskets meeting ASTM C443.
 7. Prior to delivery of any size precast manhole section to jobsite, conduct yard test at point of manufacture.
 8. Precast sections to be tested will be selected at random from stockpiled material to be supplied for the job.
- C. Fiberglass Manholes
1. Fiberglass manholes shall comply with the requirements of ASTM D3753.
 2. Manhole cylinders, manway reducers, and connectors shall be produced from glass fiber-reinforced polyester resin with the construction determined by the particular process of manufacture and configuration. The process may include contact molding, compression molding, pultrusion, etc. The manholes shall provide an area from which a grade ring can be installed to accept a typical metal ring and cover and have the strength to support H-20 traffic loading without damage to the manhole.
 3. All manholes shall be watertight.
 4. Manhole shall be a one-piece monolithic designed unit.
 5. Exterior Surface:
 - a. For a UV inhibitor the resin on the exterior surface of the manhole shall have a gray pigment added for a minimum thickness of 0.125 in. or a UV inhibitor shall be added directly to the resin to prevent photo-degradation. Mixing lots of resin from different manufacturers shall not be permitted.
 6. All manholes must have an anti-flotation ring.
 7. Minimum bottom thickness shall be 0.5 in.
 8. All manholes shall be marked in letters minimum 1 in' high with the following information:
 - a. Manufacturer's name or trademark.
 - b. Manufacturer's factory location.
 - c. Manufacturer's serial number.
 - d. Manhole length.
 - e. ASTM designation.
 - f. Installation assist marks (vertical lines 90 degrees apart at bas of manhole).

2.6 PRECAST BASE SECTIONS AND BASES

- A. As specified in other sections of specifications.
- B. All precast bases shall be monolithic.

2.7 MANHOLE EXTENSIONS

- A. In general, provide manhole extensions on manholes in streets or other locations where a subsequent change in existing grade may be likely. Limit extensions to maximum height of 12 inches.
- B. Concrete Grade Rings for Extensions: Maximum 6 inches high with a minimum of one No. 2 reinforcing bar centered in the ring.

2.8 PREFORMED PLASTIC GASKETS

- A. Preformed plastic gaskets may NOT be used on this Project.

2.9 MANHOLE FRAMES AND COVERS

- A. Cast or ductile iron of size and shape with the words SANITARY SEWER in 2-inch raised letters.

- B. Castings: Tough, close-grained gray iron, sound smooth, clean, free from blisters, blowholes, shrinkage, cold shuts, and defects.
- C. Conform to ASTM A48, Class 30B for cast iron ASTM A536, Grade 60-40-12 for ductile iron/
- D. Plane or grind bearing surfaces to ensure flat, true surfaces.
- E. Covers: True and seat within ring at all points.

2.10 MANHOLE COATING

- A. Combination Coating
 - 1. Kernoes SewperCoat 2000 HR.
- B. Cementitious Coating
 - 1. Permaform CR-9000 (1-inch-thick application).
 - 2. Strong-Seal MS-2C (1-inch-thick application).
 - 3. Standard Cement Material Inc. Reliner (1-inch-thick application).
 - 4. Quadex Cement Material Inc. Reliner (1-inch-thick application).
 - 5. ConShield Biotech Armor (1-inch-thick application).
- C. Epoxy Coating
 - 1. Raven 405 Series High Build Epoxy Liner
 - 2. Spray Wall polyurethane System.
 - 3. Carboline Plasite 4500.

2.11 TRACER WIRE FOR NONMETALLIC PIPING

- A. Tracer wire shall be minimum 12-gauge (AWG) single strand, insulated copper wire with high molecular weight polyethylene (HMWPE) insulation, specifically manufactured for direct burial applications.
- B. Provide tracer wire in sufficient length to be continuous over each separate run of non-metallic pipe.
- C. All spliced or repaired wire connections in the tracer wire system shall be made using approved connectors.
- D. Tracer wire to have green insulation.

2.12 WARNING TAPE

- A. Detectable underground aluminum warning tape shall be minimum 3 inches wide, minimum 5 mils thick. Tape to be color coded according to American Public Works Association (APWA) Uniform Color Codes.

2.13 MARKING

- A. Pipe and tubing shall be permanently marked in accordance with all applicable standards. Marking shall be heat stamped indent print and shall remain legible under normal handling and installation practices.
- B. Fittings shall be marked on the body or hub. Marking shall be in accordance with the applicable standard depending on the fitting type. Mechanical fittings shall be marked with size, body material designation code, pressure rating, and the Manufacturer's name or trademark.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine the areas and conditions under which sanitary sewer system work is to be installed and do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

3.2 HDPE JOINING METHODS

- A. Butt Fusion
 - 1. The pipe shall be joined by the butt fusion procedure outlined in ASTM F2620 or PPI TR-33.

2. All fusion joints shall be made in compliance with the pipe or fitting Manufacturer's recommendations.
 3. Fusion joints shall be made by qualified fusion technicians per PPI TN-42.
 4. Butt fusions performed between pipe ends or pipe ends and fitting outlets shall be within the following allowable wall mismatches:
 - a. 2 DR difference for pipe and fitting diameters 6 inch IPS and smaller.
 - b. 1 DR difference for above 6 inch through 18 inch.
 - c. No difference for diameters above 18 inch.
 5. The difference in DR's is determined from the following DR values: 7.3, 9, 11, 13.5, 17, 21, 26, and 32.5.
- B. Saddle Fusion
1. Saddle fusion shall be done in accordance with ASTM F2620 or PPI TR-41 or the fitting Manufacturer's recommendations and PPI TR-41.
 2. Saddle fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past year on the equipment to be utilized on the project.
- C. Socket Fusion
1. Molded socket fusion fittings are only to be used for joining of HDPE pipe from ½ inch to 2 inch in size.
 2. Socket fusion shall be done in accordance with ASTM F2620 or the fitting Manufacturer's recommendations.
 3. Socket fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past year on the equipment to be utilized on the project.
- D. Electrofusion
1. Electrofusion shall be performed in accordance with ASTM F1290 and PPI TN-34 or Manufacturer's recommendations.
 2. Electrofusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past year on the equipment to be utilized on the project.
- E. Other Methods of Joining
1. Polyethylene pipe and fittings may be joined together or to other materials through the use of flange adapters with back-up rings, mechanical couplings designed for connecting polyethylene pipe and fittings to itself or to another material or mechanical joint (MJ) adapters. The Manufacturer of the joining device shall be consulted for proper joining procedure.

3.3 INSTALLATION OF CONDUIT

- A. General:
1. Install conduit in accordance with governing authorities having jurisdiction, except where more stringent requirements are indicated.
 2. Inspect conduit before installation to detect any apparent defects. Mark defective materials with white paint and promptly remove from the Project Site.
 3. Lay conduit beginning at the low point of the system, true to the grades and the alignment indicated with unbroken continuity of invert.
 4. Install gaskets in accordance with manufacturer's recommendations for the use of lubricants, cements, and other types of special installation requirements.
 5. After inspection of cast iron soil pipe, and at least 48 hours prior to backfilling, apply a single coat of high-build bituminous coating to the external surfaces to attain a dry film thickness of not less than 12 mils.
- B. Handling: Carefully remove pipe from trucks; do not "whip" over the side. Handle pipe and accessories to ensure delivery to trench in sound, undamaged condition. Carry pipe into position; do not drag. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare

- ends of the pipe. Thoroughly clean pipe interior and accessories of foreign matter before lowering into trench, and keep clean during laying operations by plugging or other approved method. Inspect pipe before laying for defects; remove and replace defective material. Rubber gaskets that are not to be installed immediately shall be stored in a cool and dark place.
- C. Cut pipe in a neat and workmanlike manner. Unless otherwise recommended by the pipe manufacturer and authorized by the Owner's Representative, cutting shall be done with an approved type mechanical cutter. Wheel cutters shall be used when practicable.
 - D. Location: Do not place sanitary sewer pipes in the same ditch with water lines; separate water lines from sewer lines by at least 10 feet, unless otherwise approved by the Engineer.
 - E. Pipe Bedding: Provide sand, as per Section 31 00 00, bedding for all sizes and depths of sewer pipe as detailed on Drawings and specified in Section 31 00 00.
 - F. Joint Deflection: Under no circumstances will the joint deflections recommended by the manufacturer of the pipe used be exceeded.
 - G. Joint Adapters: Make joints between cast iron pipe and other types of pipe with standard manufactured cast iron adapters and fittings.
 - H. Install HDPE pipe in compliance with the requirements of ASTM D2321.
 - I. Placing and Laying Pipe: Pipe and accessories shall be carefully lowered into the trench by means of derrick, ropes, belt slings, or other authorized equipment. Under no circumstances shall any of the water line materials be dropped or dumped into the trench. Except where necessary in making connections with other lines or as authorized by the A/E, pipe shall be laid with the bells facing in the direction of laying. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, couplings, and joints. Pipe that has the grade or joint disturbed after laying shall be taken up and re-laid. Pipe shall not be laid in water or when trench conditions are unsuitable for the work. Water shall be kept out of the trench until jointing is complete. When work is not in progress, open ends of pipe and fittings shall be securely closed so that no trench water, earth, or other substance will enter the pipes or fittings. Pipe ends left for future connections shall be plugged or capped and anchored as shown.
 - J. Service Connections: Locate far-side service connections and near-side service stubs as shown on Mechanical Drawings. Use wyes and tees as indicated.
 - 1. Show actual locations of installed service connections on Project Record Drawings.
 - K. Interior Inspection: Inspect conduit to determine whether line displacement or other damage has occurred.
 - 1. Make inspection after lines between manholes or manhole locations have been installed and approximately 2' of backfill is in place and at completion of Project.
 - 2. If the inspection indicates poor alignment, debris, displaced pipe, infiltration, or other defects, take whatever steps are necessary to correct such defects to the satisfaction of the Architect/Engineer.
 - L. Cleaning Conduit:
 - 1. Clear interior of conduit of dirt and other superfluous material as work progresses. Maintain a swab or drag in line and pull past each joint as it is completed.
 - 2. Place plugs in the ends of uncompleted conduit at the end of day or whenever work stops.
 - 3. Flush lines between manholes if required to removed debris.

3.4 TAP CONNECTIONS

- A. Make connections to existing underground structures so that finished work will conform as nearly as practicable to requirements specified for new work.
 - 1. Use commercially manufactured wyes for branch connections. Field cutting into conduit will not be permitted. Spring wyes into existing line and encase the entire wye, plus 6" overlap, with not less than 6" of 3,000 psi 28-day compressive strength concrete.
 - 2. For branch connections from side into existing underground structure, cut an opening into unit sufficiently large to allow 3" of concrete, with not less than 6" of 3,000 psi 28 day compressive strength, to be packed around entering connection. Cut ends of connection passing through

conduit or structure wall to conform to shape of and be flush with inside wall. On outside of conduit or structure wall, encase entering connection in 6" of concrete for a minimum length of 12" to provide additional support or collar from connection to undisturbed ground. Use an epoxy bonding compound as an interface between new and existing concrete and conduit materials.

3. Take care while making tap connections to prevent concrete or debris from entering the existing structure. Remove any debris, concrete, or other extraneous material which may accumulate.

3.5 MANHOLES

A. Concrete Bases

1. All manhole bases shall be placed on nine (9) inches of 1-1/2 sack cement/C.Y. cement stabilized sand.

B. Placing Precast Manhole Sections

1. Thoroughly clean ends of sections to be joined.
2. Thoroughly wet joint with water prior to placing mortar.
3. Place mortar on groove of lower section.
4. Set next section in place.
5. Fill joint completely with mortar of proper consistency.
6. Trowel interior and exterior surfaces smooth on standard tongue and groove joints.
7. Prevent mortar from premature drying and curing by applying an approved curing compound or comparable approved product.
8. Do not use mortar mixed for longer than thirty minutes. Chip out and replace cracked or defective mortar.
9. Completed Manhole: Rigid and watertight.

C. Fiberglass Manholes

1. Fiberglass manholes shall be installed according to manufacturer's installation instructions.

D. Manhole Invert

1. Manhole invert shall be the flow line of the pipe or as specified on the drawings.

E. Manhole Extensions

1. Install extension as shown, to height not exceeding 12 inches.
2. Lay grade rings in mortar with sides plumb and tops level. Seal joints with mortar as specified for manhole sections and make watertight.

F. Manhole Frames and Covers

1. Install on top of manholes to positively prevent infiltration of surface or groundwater into manholes.
2. Set frames in bed of mortar with mortar carried over flange as shown.
3. Set tops of covers flush with surface of adjoining pavement. Set tops of covers outside of pavement areas flush with ground surface, unless otherwise shown or directed.
4. Covers shall be adjusted to final grade at no additional cost to the Owner.

G. Backfilling and Compaction

1. General: Backfill open-cut trenches closely following laying, jointing and bedding of pipe, and after initial inspection and testing are completed. Comply with the requirements of Section 31 00 00. All trenching in existing paved areas or areas to be paved shall comply with the requirements of Section 31 00 00.
2. Installation of Tracer Wire
 - a. Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe at minimum 10 foot intervals in such a manner that it will not be displaced during construction operations. Extend ends of tracer wire into valve boxes and anchor in place.
3. Installation of Detectable Warning Tape
 - a. Install detectable warning tape 12 inches below finished grade.

3.6 TESTING

A. Piping

1. General: During construction, perform leakage testing and displacement testing as work progresses. No more than 500 linear feet of installed sewer shall be allowed to remain untested. After backfilling and removing debris from each section of sewer line, conduct a line acceptance test under the observation of the Owners Designated Representative.
2. Testing of sanitary sewer pipe and manholes for leakage and testing of flexible pipe for deflection shall be inspected by a qualified inspector.
3. Leakage Testing: Test the sanitary sewer lines in strict accordance with the following leakage test using low-pressure air. If the test results indicate an unacceptable installation, locate the source of leakage, correct the defect, and retest until the installation is proven satisfactory. Testing shall comply with the requirements of ASTM F1417 Standard practice for Installation Acceptance of Plastic Non-Pressure Sewer Lines Using Low-Pressure Air.
 - a. Minimum Requirements for Equipment
 - 1) Control Panel.
 - 2) Low pressure air supply connected to control panel.
 - 3) Pneumatic plugs of acceptable size for diameter of pipe to be tested; capable of withstanding internal test pressure without leaking or requiring external bracing.
 - 4) Air hose from control panel to:
 - a) Air supply.
 - b) Pneumatic plugs.
 - c) Sealed line for pressurizing.
 - d) Sealed line for monitoring internal pressure.
 - b. Test pneumatic plugs: Test plugs before using in actual test installation.
 - 1) Place one length of pipe on ground and seal at both ends of pneumatic plugs to be checked.
 - 2) Pressurize plugs to 25 psig; then pressurize sealed pipe to 5 psig.
 - 3) Plugs are acceptable if they remain in place against the test pressure without external aids.
 - c. Compensation for Groundwater Pressure:
 - 1) Where groundwater exists, install a capped pipe nipple at the same time the sewer line is placed. Use a 1/2-inch capped pipe nipple approximately 10 inches long. Make installation through the manhole wall on top of the sewer line where the line enters the manhole.
 - 2) Immediately before performing the line acceptance test, remove the pipe cap, clear the pipe nipple with air pressure, and connect a clear plastic tube to pipe nipple. Support the tube vertically and allow water to rise in the tube. After the water stops rising, measure the height in feet of water over the invert of the pipe. Divide this height by 2.3 feet/psi to determine the groundwater pressure to be used in line testing.
 - d. Line Testing: After pneumatic plugs have been checked, place plugs in line at manholes and inflate lugs to 25 psig. Introduce low-pressure air into the sealed line until the internal air pressure reaches 3.5 psig greater than the groundwater pressure. Allow at least 2 minutes for air pressure to stabilize. Once the pressure is stabilized, the minimum time allowable for the pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch gauge shall be as required the table below. The test may be stopped if no pressure loss has occurred during the first 25% of the calculated testing time. If any pressure loss or leakage has occurred during the first 25% of the testing period, then the test shall continue for the entire test duration or until failure.

Pipe Diameter (inches)	Minimum Time (seconds)	Maximum Length for Minimum Time (feet)	Time for Longer Length (seconds/foot)

6	340	398	0.855
8	454	298	1.520
10	567	239	2.374
12	680	199	3.419
15	850	159	5.342
18	1020	133	7.693
21	1190	114	10.471
24	1360	100	13.676
27	1530	88	17.309
30	1700	80	21.369
33	1870	72	25.856

4. Deflection Testing
 - a. Deflection test shall be performed on all flexible pipes. For pipelines with inside diameters less than 27 inches, a rigid mandrel shall be used to measure deflection. For pipelines with an inside diameter 27 inches and greater, a method approved by the Owner or Engineer shall be used to test for vertical deflections. The test shall be conducted after the final backfill has been in place at least 30 days. No pipe shall exceed a deflection of five percent. If a pipe should fail to pass a deflection test, the problem shall be corrected and a second test shall be conducted after the final backfill has been in place an additional 30 days. The tests shall be performed without mechanical pulling devices.
 - b. Deflection testing must comply with the requirements of Texas Administrative Code, Title 30, Part 1, Chapter 217, Subchapter C, Rule 217.57.
 - 1) Mandrel Sizing: The rigid mandrel shall have an outside diameter (O.D.) equal to 95% of the inside diameter (I.D.) of the pipe. The inside diameter of the pipe, for the purpose of determining the outside diameter of the mandrel, shall be the average outside diameter minus two minimum wall thicknesses for O.D. controlled pipe and the average inside diameter for I.D. controlled pipe. All dimensions shall be per appropriate standard. Statistical or other "tolerance packages" shall not be considered in mandrel sizing.
 - 2) Mandrel Design: The rigid mandrel shall be constructed of a metal or a rigid plastic material that can withstand 200 psi without being deformed. The mandrel shall have nine or more "runners" or "legs" as long as the total number of legs is an odd number. The barrel section of the mandrel shall have a length of at least 75% of the inside diameter of the pipe. Adjustable or flexible mandrels are prohibited.
- B. Building Sewer Testing
 1. Building sewer is to be tested in compliance with IPC Section 312.6.
 - a. Gravity sewer tests shall consist of plugging the end of the building sewer at the point of connection with the public sewer, filling the building sewer with water, testing with not less than a 10-foot head of water and maintaining such pressure for 15 minutes.
- C. Manhole Testing: Test manholes per the requirements of Texas Administrative Code, Title 30, Part 1, Chapter 217, Subchapter C, Rule 217.58.
 1. Hydrostatic Testing
 - a. The maximum leakage for hydrostatic testing or any alternative test methods is 0.025 gallons per foot diameter per foot of manhole depth per hour.
 - b. To perform a hydrostatic exfiltration test, an owner shall seal all wastewater pipes coming into a manhole with an internal pipe plug, fill the manhole with water, and maintain the test for at least one hour.
 - c. A test for concrete manholes may use a 24-hour wetting period before testing to allow saturation of the concrete.
 2. Vacuum Testing

- a. To perform a vacuum test, plug all lift holes and exterior joints with a non-shrink grout and plug all pipes entering a manhole.
 - b. No grout may be placed in horizontal joints before testing.
 - c. Stub-outs, manhole boots, and pipe plugs must be secured to prevent movement while a vacuum is drawn.
 - d. Use a minimum 60 inch/lb. torque wrench to tighten the external clamps that secure a test cover to the top of a manhole.
 - e. A test head must be placed at the inside of the top of a cone section, and the seal inflated in accordance with the manufacturer's recommendations.
 - f. There must be a vacuum of 10 inches of mercury inside a manhole to perform a valid test.
 - g. A test does not begin until after the vacuum pump is off.
 - h. A manhole passes the test if after 2.0 minutes and with all valves closed, the vacuum is at least 9.0 inches of mercury.
- D. Manhole Coating
- 1. After a manhole has passed all testing, approved coating(s) shall be applied. Coatings shall consist of either:
 - a. Combination Coating – 1" thick application installed per manufacturer's instructions, or
 - b. Cementitious and Epoxy Coating
 - 1) Cementitious Coating – 1" thick application installed per manufacturer's instructions.
 - 2) Epoxy Coating – 125 mil thick application installed per manufacturer's instructions.
 - E. New sanitary sewers outside buildings shall be television inspected. Videotape shall be turned over to the Owner.

3.7 CLEAN UP

- A. Upon completion of all sewer lines and appurtenances, all debris and surplus materials resulting from work shall be removed.

END OF SECTION

SECTION 0333001 – SANITARY SEWERAGE UTILITIES

PART 1 – GENERAL

1.1 SUMMARY

- A. This section includes materials, installation, and testing requirements for gravity sanitary sewer systems, including:
- B. PVC and ductile iron sewer mains
- C. Manholes and cleanouts
- D. Connections to existing systems
- E. Appurtenances per SAWS standards

1.2 RELATED DOCUMENTS

- A. Section 31 20 00 – Earth Moving
- B. Section 03 30 00 – Cast-in-Place Concrete
- C. SAWS Standard Specifications and Drawings
- D. SAWS Utility Service Regulations

1.3 REFERENCES

- A. SAWS Construction Specifications
- B. SAWS Approved Products List
- C. ASTM D3034, ASTM F679, ASTM C478
- D. AWWA, TCEQ, and City of San Antonio standards

1.4 SUBMITTALS

- A. Product data and shop drawings
- B. SAWS Product Submittal Application (if applicable)
- C. Test reports and as-built drawings
- D. Preconstruction submittals per SAWS checklist

1.5 QUALITY ASSURANCE

- A. All materials and workmanship must comply with SAWS Construction & Material Specifications
- B. Use only SAWS-approved products
- C. Contractor must coordinate with SAWS for inspections and approvals

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials per SAWS guidelines
- B. Protect from contamination and damage
- C. Maintain end caps on pipes

PART 2 – PRODUCTS

2.1 PIPING MATERIALS

- A. PVC Gravity Sewer Pipe: ASTM D3034 SDR 35 ($\leq 15"$), ASTM F679 ($\geq 18"$)
- B. Ductile Iron Pipe (DIP): AWWA C151, for deep installations or where required
- C. HDPE: Only with SAWS approval for trenchless installations

2.2 MANHOLES AND INLETS

- A. Precast Concrete Manholes: ASTM C478, with SAWS-approved coatings
- B. Covers and Frames: Cast iron, traffic-rated, marked "SAWS SEWER"
- C. Drop Connections: Per SAWS standard detail

2.3 ACCESSORIES

- A. Joint Sealants
- B. Flexible couplings: Fernco or equal, SAWS-approved
- C. Cleanouts: Per SAWS standard detail
- D. Tracer wire: Required for all non-metallic pipe

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Verify that site conditions are suitable for installation.
- B. Notify Engineer of any conditions that may adversely affect installation.

3.2 INSTALLATION

- A. Install per SAWS Construction Specifications
- B. Maintain minimum slope and cover
- C. Proper bedding and backfill per SAWS standards
- D. Use laser or GPS for alignment verification

3.3 TESTING

- A. Low-pressure air test: Per ASTM F1417
- B. Mandrel test: For deflection in flexible pipe
- C. Vacuum test: For manholes per ASTM C1244
- D. All testing must be witnessed and approved by
- E. Repair or replace defective work.

3.4 CLEANING

- A. Remove debris and excess materials from site.
- B. Restore all disturbed areas to original or better condition
- C. Submit as-built drawings to SAWS

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes storm sewer system and appurtenances from a point five (5) feet outside the building to the point of disposal.

1.3 RELATED SECTIONS

- A. Section 03 30 00 – Cast-In-Place Concrete.
B. Section 31 00 00 – Site Earthwork.
C. Section 31 50 00 – Excavation Support and Protection.
D. Section 33 46 00 – Subdrainage

1.4 REFERENCES

- A. American Society of Testing and Materials (ASTM), 1916 Race Street, Philadelphia, Pennsylvania 19103. All references shall be to current active standard.
1. ASTM A36 – Standard Specification for Carbon Structural Steel.
 2. ASTM A48 – Standard Specification for Gray Iron Castings.
 3. ASTM A123 – Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
 4. ASTM A240 – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 5. ASTM A536 – Standard Specification for Ductile Iron Castings.
 6. ASTM A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 7. ASTM B139 – Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.
 8. ASTM C33 – Standard Specification for Concrete Aggregates.
 9. ASTM C40 – Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
 10. ASTM C76 – Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
 11. ASTM C88 – Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
 12. ASTM C94 – Standard Specification for Ready-Mixed Concrete.
 13. ASTM C117 – Standard Test Method for Materials Finer than 75- μm (No. 200) Sieve in Mineral Aggregates by Washing.
 14. ASTM C131 – Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 15. ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 16. ASTM C150 – Standard Specification for Portland Cement.
 17. ASTM C270 – Standard Specification for Mortar for Unit Masonry.
 18. ASTM ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 19. ASTM C387 – Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
 20. ASTM C443 – Standard Specification for Joints for Pipes and Manholes Using Rubber Gaskets.
 21. ASTM C478 – Standard Specification for Precast Reinforced Concrete Manhole Sections.
 22. ASTM C595 – Standard Specification for Blended Hydraulic Cements.

23. ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 24. ASTM C786 – Standard Test Method for Fineness of Hydraulic Cement and Raw Materials by the 300- μ m (No. 50), 150- μ m (No. 100), and 75- μ m (No. 200) Sieves by Wet Methods.
 25. ASTM C858 – Standard Specification for Underground Precast Concrete Utility Structures.
 26. ASTM C891 – Standard Practice for Installation of Underground Precast Concrete Utility Structures.
 27. ASTM C923 – Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
 28. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer
 29. ASTM D4101 – Standard Specification for Polypropylene Injection and Extrusion Materials.
 30. ASTM F477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
 31. ASTM F593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 32. ASTM F594 – Standard Specification for Stainless Steel Nuts.
- B. American Water Works Association (AWWA), 6666 W. Quincy Ave., Denver, CO 80235.
1. AWWA C110-82, Ductile-Iron and Gray-Iron Fittings, 3-inch through 48-inch for Water and Other Liquids.
- C. American Concrete Institute (ACI):
1. ACI 301, Specifications for Structural Concrete for Buildings

1.5 SUBMITTALS

- A. General: Refer to Section 01 33 00 - Submittal Procedures, and Section 01 33 23 – Shop Drawings, Product Data and Samples, for submittal requirements and procedures.
- B. Shop Drawings
1. Submit shop drawings for the system, showing pipe sizes, locations, elevations, and slopes for horizontal runs.
 2. Submit for review Shop Drawings showing design, reinforcing steel placement, and construction of all concrete structures.
 3. Cast-in-Place Structures: Details of construction.
 4. Construction details of structure frames, covers, and grates.
- C. Product Data:
1. Submit manufacturers' product data of inlets, junction boxes, piping and appurtenances.
 2. Proposed mix designs in accordance with ACI 301, Chapter 3.9. Each proposed mix design shall be accompanied by a complete standard deviation analysis based on no less than thirty (30) consecutive strength tests or by three laboratory trial mixtures with confirmation tests.
 3. Mill test certificates of supplies concrete reinforcing, indicating results of chemical and physical analysis.
 4. Proposed curing method for cast-in-place concrete structures.
 5. Submit manufacturer's certificates for the following:
 - a. Certificate of Compliance confirming that the pipe meets or exceeds specified requirements as stated in ASTM C478.
 - b. Precast Structure Sections: Results of tests performed on representative sections to be furnished.
 - c. Fly Ash: certifications that each fly ash shipment meets specified requirements.
- D. As-Builts, locating actual horizontal and vertical location of installed storm sewer piping, inlets, manholes, and related work shall be prepared and submitted to the Owner.

1.6 QUALITY CONTROL

- A. The testing laboratory shall sample and test concrete in accordance with the provisions of these specifications.
- B. Concrete Mix Designs

1. Selection of Proportions: Proportions of ingredients for concrete mixes shall be determined by an independent testing laboratory or qualified concrete supplier in accordance with the requirements of ACI 301, Chapter 3. If testing laboratory provides concrete mix designs, it shall be selected by the Contractor, approved by the Owner's Designated Representative, and paid by the Contractor.
2. Required average strength above specified strength: Determination of required average strength above specified strength shall be based on the standard deviation record of the production facility in accordance with ACI 301. Calculation of standard deviation of compressive strength results shall be made in accordance with ACI 214. If a suitable record of strength tests is not available, proportions shall be selected on the basis of laboratory trial batches to produce an average strength greater than the specified strength by the amount defined in ACI 301, Table 3.9.2.2.

PART 2 - PRODUCTS

2.1 CONDUIT MATERIALS

- A. General: Furnish ells, tees, reducing tees, wyes, couplings, increasers, crosses, transitions, and end caps of the same type and class of material as the conduit, or of material having equal or superior physical and chemical properties as approved by the A/E.
- B. Reinforced Concrete Pipe (RCP)
 1. ASTM Class III or IV as required based on pipe cover.
 2. All reinforced concrete pipe to be bell and spigot or tongue and groove.
 3. Joint assembly design shall be reinforced concrete incorporating a fully retained single or double rubber gasket complying with ASTM C443.
- C. High-Density Polyethylene (HDPE) Pipe and Fittings
 1. Provide HDPE pipe and fittings that meet the requirements of AASHTO M 294.
 - a. Raw Materials: The pipes and fittings shall be manufactured from virgin Polyethylene (PE) compounds, which conform to the requirements of cell class 335400C as defined in ASTM D3350, except that carbon black content shall not exceed 5%. PE compounds shall meet the Environmental Stress Crack Resistance according to the SP-NCTL test set forth in AASHTO M294.
 - b. Designation of Type: The HDPE pipes used for gravity flow drainage applications shall be of Type S (outer corrugated wall with smooth inner liner) or Type D (inner and outer smooth walls braced circumferentially or spirally with projections or ribs).
 - c. Section Properties: Minimum wall thickness of the inner walls of Type S pipe and inner and outer walls of Type D shall be as specified in Section 7.2.2 of AASHTO M 294. The pipe stiffness at 5% deflection, when determined in accordance with ASTM D2412, shall be as specified in Section 7.4 of AASHTO M 294.
 2. Marking: All pipes shall be clearly marked at intervals of not more than 12 feet, and fittings and couplings shall be clearly marked as follows:
 - a. Manufacturer's name or trademark.
 - b. Nominal Size.
 - c. Specification designation (e.g. AASHTO M 294).
 - d. Plant designation code.
 - e. Date of manufacture.
 3. Joints
 - a. Joints shall be installed such that the connection of pipe sections will form a continuous line free from irregularities in the flow line.
 - b. Joints shall conform to one of the following:
 - 1) Integral Bell and Spigot. The bell shall overlap a minimum of two corrugations of the spigot end when fully engaged. The spigot end shall have an O-ring gasket that meets ASTM F477.

- 2) Exterior Bell and Spigot. The bell shall be fully welded to the exterior of the pipe and overlap the spigot end so that the flow lines and ends match when fully engaged. The spigot end shall have an O-ring gasket that meets ASTM F477.
 - 3) Watertight Joints. Joints meeting the requirements of ASTM D3212.
- D. Polyvinyl Chloride (PVC) Pipe
1. ASTM D3034, SDR-35, for gasketed joints. Provide elastomeric gasket seals conforming to ASTM F477.

2.2 CONCRETE

A. Cement

1. Type I Portland cement shall conform to all the requirements of ASTM C150 with the following modifications:
 - a. The specific surface area of Types I and II shall not exceed 2000 square centimeters per gram as measured by the ASTM C115 Standard Test for Fineness Of Portland Cement by the Turbidimeter. With each shipment, the Contractor shall furnish the Engineer a statement as to the specific surface area of the cement, expressed in square centimeters per gram. When Type II cement is used in concrete piling or prestressed concrete members, the specific surface area requirement is waived. When white cement is specified on the plans for use in concrete, Type I or Type II cement used need not meet the above limit on specific surface area.
 - b. The Gillmore time of set test shall govern.
 - c. When the cement is to be used in concrete with potentially-reactive aggregates, one of the following shall be adhered to: the cement shall have an alkali content $\text{Na}_2\text{O} + 0.658 \text{K}_2\text{O}$ of 0.60 percent or less; the cement shall be Type IP; or the cement may have an alkali content in excess of 0.6 percent provided 25 to 35 percent, by absolute volume, of the cement is replaced with fly ash meeting the requirements of ASTM C618 and has an available alkali content of 1.5 percent or less.
2. Coarse Aggregate
 - a. Coarse aggregate shall be washed and shall consist of durable particles of gravel, crushed blast furnace slag, crushed stone, or combinations thereof and shall be free from frozen material or injurious amounts of salt, alkali, vegetable matter, or other objectionable material either free or as an adherent coating. When white Portland cement is specified, the coarse aggregates used in the concrete shall be light colored. Quality shall be reasonably uniform throughout. Coarse aggregate shall not contain more than 0.25 percent by weight of clay lumps, nor more than one (1.0) percent by weight of shale, nor more than five (5.0) percent by weight of laminated and/or friable particles when tested in accordance with Test Method ASTM D1863. Coarse aggregate from each source shall have a wear of not more than 40 percent when tested in accordance with Test Method ASTM C131.
 - b. Unless otherwise shown on the plans, coarse aggregate from each source will be subjected to five (5) cycles of both the sodium sulfate and the magnesium sulfate soundness test in accordance with Test Method ASTM C88. When the loss is greater than 12 percent with sodium sulfate and/or 18 percent with magnesium sulfate, further testing will be required prior to acceptance or rejection of the material. A satisfactory record under similar conditions of service and exposure will be considered in the evaluation of material failing to meet these requirements.
 - c. When tested in accordance with Test Method ASTM C136, the coarse aggregate, including combinations of aggregates when used, shall conform to the gradation requirements of ASTM C33 gradations 7, 57, 67 or 467.
 - d. The loss by decantation in accordance with Test Method ASTM C117 plus the allowable weight of clay lumps shall not exceed one (1) percent, or the value shown on the plans, whichever is smaller. In the case of aggregates made primarily from the crushing of stone, if the material finer than the 200 sieve is definitely established to be the dust of fracture,

essentially free from clay or shale, as established by Test Method ASTM C117, the percent may be increased to 1.5.

3. Fine Aggregate
 - a. Fine aggregate shall be washed and consist of clean, hard, durable and uncoated particles of natural or manufactured sand or a combination thereof, with or without a mineral filler. When white Portland cement is specified, the fine aggregate used in the concrete shall be light colored. It shall be free from frozen material or injurious amounts of salt, alkali, vegetable matter or other objectionable material and it shall not contain more than 0.5 percent by weight of clay lumps. When the aggregate is subjected to the color test for organic impurities in accordance with Test Method ASTM C40, the test result shall not show a color darker than standard.
 - b. Unless otherwise shown on the plans, the acid insoluble residue of fine aggregate used in concrete subject to direct traffic shall be not less than 60 percent by weight when tested in accordance with Test Method Tex-612-J.
 - c. When tested in accordance with Test Method ASTM C136, the fine aggregate or combinations of aggregates, including mineral filler, shall conform to the gradation requirements shown below:

Sieve	Percent Retained
3/8"	0
No. 4	0 to 5
No 8	0 to 20
No. 16	15 to 50
No. 30	35 to 75
No. 50	65 to 90
No. 100	90 to 100
No. 200	97 to 100

- d. Where manufactured sand is used in lieu of natural sand, the percent retained on the No. 200 sieve shall be 94 to 100.
 - e. Where the sand equivalent value is greater than 85, the retainage on the No. 50 sieve may be 65 to 94 percent.
 - f. Fine aggregate will be subjected to the Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate (Test Method ASTM D 2419. The sand equivalent shall not be less than 80 unless otherwise shown on the plans.
 - g. For all classes of concrete, the fineness modulus shall be between 2.30 and 3.10 as determined by Test Method ASTM C786. The fineness modulus for class K shall be 2.6 to 2.8 unless otherwise shown on the plans.
4. Slump shall not exceed four (4) inches.
 5. Concrete shall be "Class C", minimum 28-day compressive strength of 3600 psi and maximum W/C (water/cement) ratio of 0.45.
 6. Mixing Water
 - a. Water for use in concrete and for curing shall be free from oils, acids, organic matter or other deleterious substances and shall not contain more than 1000 parts per million of chlorides as Cl nor more than 1000 parts per million of sulfates as SO₄.
 - b. Water from municipal supplies approved by the State Health Department will not require testing, but water from other sources will be sampled and tested before use in concrete. Tests shall be made in accordance with AASHTO T26.
 - c. Water used in white Portland cement concrete shall be free from iron and other impurities which may cause staining or discoloration.

2.3 MASONRY MATERIALS

- A. Masonry Mortar ASTM C270, Type M.
1. For minor amounts of mortar, packaged materials complying with ASTM C387, Type M will be acceptable.

2.4 MISCELLANEOUS MATERIALS

- A. Basins, Frames and Gratings:
1. Cast or ductile iron of size and shape with the words STORM SEWER in 2-inch raised letters.
 2. Castings: Tough, close-grained gray iron, sound smooth, clean, free from blisters, blowholes, shrinkage, cold shuts, and defects.
 3. Conform to ASTM A48, Class 30B for cast iron ASTM A536, Grade 60-40-12 for ductile iron.
 4. Plane or grind bearing surfaces to ensure flat, true surfaces.
 5. Covers: True and seat within ring at all points.
 6. Comply with requirements of FS RR-F-621, for type and style required.
- B. Steel Expansion Joint Dowels:
1. Dowel bars shall be round smooth steel conforming to ASTM A36, Grade 60. One end shall be coated with asphalt mastic.
- C. Reinforcing Steel
1. Reinforcing steel shall be deformed and conform to ASTM A615, new billet steel, Grade 60.
 2. Reinforcing steel to be structurally welded shall comply with ASTM A706 or shall have a carbon equivalent (C.E.) of not more than 0.55%. A report of chemical analysis, showing the percentages of elements necessary to establish the carbon equivalency, will be required of all reinforcing steel that is to be structurally welded. Carbon equivalency will be calculated using the following formula:

$$C.E. = \frac{\%C}{6} + \frac{\%Mn}{40} + \frac{\%Cu}{20} + \frac{\%Ni}{10} + \frac{\%Cr}{50} - \frac{\%Mo}{10} - \frac{\%V}{10}$$

2.5 CURING MATERIALS

- A. Membrane Curing: The liquid membrane-forming curing compound shall comply with ASTM C309.
- B. Cotton mats shall consist of a filling material of cotton "bat" or "bats" (min. 12 oz. per sq. yd.); covered with unsized cloth (min. six (6) oz. per sq. yd.); tufted or stitched to maintain stability; shall be free from tears; and shall be in good general condition.
- C. Polyethylene sheeting shall be four (4) mil. minimum thickness and free from visible defects. It shall be clear or opaque white except when the temperature during the curing period does not exceed 60 F or when applicable to control temperature during mass pours.
- D. Burlap-polyethylene mats shall be made from burlap impregnated on one side with a film of opaque white pigmented polyethylene and free from visible defects.
- E. Laminated mats shall have not less than one (1) layer of an impervious material such as polyethylene, vinyl plastic or other acceptable material (either as a solid sheet or impregnated into another fabric) and shall be free of visible defects.

2.6 PREFORMED BITUMINOUS JOINT FILLER

- A. Bituminous type conforming to ASTM D994 or D1752 unless otherwise specified or shown.

2.7 MANHOLES

- A. Concrete
1. Ready-mixed, meeting ASTM C94, Option A, and the following:
 - a. Manhole Base Minimum Compressive Strength: conforming to the requirements of ASTM C478.
 - b. Riser Minimum Compressive Strength: 3,000 psi at 28 days.
 - c. Riser Maximum Aggregate Size: 1-1/2 inches.
 - d. Riser Slump: 2 to 4 inches.
 2. Cement shall conform to one of the following:

- a. ASTM C150, Type II
- b. ASTM C150, Type I, limited to a maximum tricalcium aluminate (C3A) content of 12 percent and combined with fly ash as specified herein.
- c. ASTM C595, Type IP blended hydraulic cement provided the cement conforms to ASTM C150 and fly ash is as specified herein.
3. Minimum Portland Cement Content: 564 pounds per cubic yard for concrete without fly ash.
4. Minimum Cementitious Materials (Portland Cement plus Fly Ash): 490 pounds per cubic yard for concrete with fly ash.
5. Amount of Fly Ash: Minimum 15 percent, and maximum 25 percent, of the cementitious materials, unless otherwise directed by the Owner's Designated Representative.
6. Water/Cement (Cementitious Materials) Ratio: Maximum of 0.49.
- B. Fly Ash
 1. Provide as specified in Section 03 30 00.
- C. Mortar
 1. Standard premixed meeting ASTM C387, or proportion 1 part Portland cement to 2 parts clean, well-graded sand, which will pass a 1/8-inch screen.
 2. Admixtures: May be included but do not exceed the following percentages of weight of cement.
 3. Hydrated Lime: 10 percent.
 4. Diatomaceous Earth or Other Inert Material: 5 percent.
 5. Consistency
 - a. Tongue-and-Groove Type Joint: Such that mortar will readily adhere to pipe.
 - b. Confined Groove (Keylock) Joint: Such that excess mortar will be forced out of groove. The tongue will not provide support for the section being placed.
- D. Bonding Agent
 1. As manufactured by:
 - a. Sika Corp., Sikastix 370.
 - b. Sika Corp., Sikador Hi-Mod.
 - c. Horn Co., Epoxite Binder 2385.
- E. Forms
 1. Trench walls, large rock, or earth are not acceptable form material.
 2. Exposed Surfaces: Plywood or steel panels.
- F. Reinforcing Steel
 1. Conform to ASTM A615, Grade 60, deformed bars.
- G. Cast-in-Place Structures
 1. Acceptable subject to the Owner's Representative's approval.
- H. Precast Structures
 1. Riser Sections
 - a. Minimum 48 inches in diameter for sanitary sewer uses and 48 inches for storm drain uses, conforming to ASTM C478.
 - b. Minimum Wall Thickness: 4 inches or 1/12 times inside diameter, whichever is greater.
 - c. Provide eccentric cones for manholes. Cones shall have same wall thickness and reinforcement as riser section.
 - d. First riser section shall be monolithic.
 - e. Top and bottom of section shall be parallel.
 - f. Confined O-ring with rubber gaskets meeting ASTM C443.
 - g. Prior to delivery of any size precast manhole section to jobsite, conduct yard test at point of manufacture.
 - h. Precast sections to be tested will be selected at random from stockpiled material to be supplied for the job.
 - i. All test specimens shall be tested and meet the permeability test requirements of ASTM C76.
 2. Precast Base Sections and Bases
 - a. As specified in other sections of specifications.

- b. All precast bases shall be monolithic.
- 3. Manhole Extensions
 - a. In general, provide manhole extensions on manholes in streets or other locations where a subsequent change in existing grade may be likely. Limit extensions to maximum height of 12 inches.
 - b. Concrete Grade Rings for Extensions: Maximum 6 inches high with a minimum of one No. 2 reinforcing bars centered in the ring.
- 4. Preformed Plastic Gaskets
 - a. Preformed plastic gaskets may NOT be used on this Project.
- 5. Manhole Access
 - a. Portable ladders, complying with OSHA standards, are to be used for accessing manholes.
 - b. Personal gas detectors complying with OSHA regulations, and other equipment required by OSHA, shall be provided by the Contractor to all appropriate personnel.
- 6. Unless otherwise shown on the plans, all drainage structures shall be precast concrete rated for H2O loading.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the areas and conditions under which storm sewer system work is to be installed and do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

3.2 EXCAVATION FOR PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

- A. Excavation of trenches and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of Section 31 00 00 EARTHWORK and the requirements specified below.
 - 1. Trenching
 - a. The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus twelve inches to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheeting and bracing, where required, shall be placed within the trench width as specified, without any over-excavation. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Owner.
 - 2. Removal of Rock
 - a. Rock in either ledge or boulder formation shall be replaced with suitable materials to provide a compacted earth cushion having a thickness between unremoved rock and the pipe of at least 8 inches or 1/2 inch for each meter foot of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Where bell-and-spigot pipe is used, the cushion shall be maintained under the bell as well as under the straight portion of the pipe. Rock excavation shall be as specified and defined in Section 31 00 00 Site Earthwork.
 - 3. Removal of Unstable Material
 - a. Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Owner's Designated Representative, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING AND COMPACTION. When removal of unstable material is due to the fault or neglect of the Contractor while performing shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the Owner.

3.3 BEDDING

- A. The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.
- B. Concrete Pipe Requirements
 - 1. When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded in granular material minimum 4 inch in depth in trenches with soil foundation. Depth of granular bedding in trenches with rock foundation shall be 1/2 inch in depth per foot of depth of fill, minimum depth of bedding shall be 8 inches up to maximum depth of 24 inches. The middle third of the granular bedding shall be loosely placed. Bell holes and depressions for joints shall be removed and formed so entire barrel of pipe is uniformly supported. The bell hole and depressions for the joints shall be not more than the length, depth, and width required for properly making the particular type of joint.
- C. Plastic Pipe Requirements
 - 1. When no bedding class is specified or detailed on the drawings, bedding for PVC and PE pipe shall meet the requirements of ASTM D2321. Bedding, haunching, and initial backfill shall be either Class IB or II material.
- D. HDPE Pipe Requirements
 - 1. When no bedding class is specified or detailed on the drawings, bedding for HDPE pipe shall be per manufacturer's recommendations.

3.4 INSTALLATION OF PIPE

- A. General:
 - 1. Install conduit in accordance with requirements of governing authorities having jurisdiction, except where more stringent requirements are specified.
 - 2. Submit copies of the manufacturer's recommendations for installation procedures of the material being placed, prior to installation.
 - 3. Inspect conduit before installation to detect apparent defects. Mark defective materials with white paint and promptly remove from the Project Site.
 - 4. Lay conduit beginning at the low point of a system, true to grades and alignment indicated, with unbroken continuity of invert.
 - 5. For concrete and PVC pipe, lay pipe with spigot end pointing in the direction of flow.
 - 6. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary.
 - 7. Install gaskets in accordance with manufacturer's recommendations; use recommended lubricants, cements, and comply with other special installation requirements.
 - 8. Cleaning Conduit:
 - a. Clear the interior of conduit of dirt and other superfluous material as the work progresses. Maintain a swab or drag in the line and pull past each joint as it is completed.
 - b. Place plugs in the ends of uncompleted conduit at the end of the day or whenever work stops.
 - c. Flush lines between manholes if required to remove collected debris.
 - 9. Interior
 - a. Make inspections after lines have been installed and approximately 2' of backfill is in place and at completion of the Project.
 - b. If the inspection indicates poor alignment, debris, displaced pipe, infiltration or other defects, take whatever steps are necessary to correct such defects subject to the approval of the Architect/Engineer.
 - 10. Trench backfill shall be per specification section 31 00 00 - Site Earthwork and the project drawings.

3.5 STRUCTURES

A. Cast-In-Place Structures

1. Equipment

- a. All equipment, tools, and machinery used for hauling materials and performing any part of the work shall be maintained in such condition as to insure completion of the work under way without excessive delays for repairs or replacement.
- b. The mixer shall be of an approved type and size that will produce uniform distribution of the material throughout the mass and shall be capable of producing concrete meeting the requirements of these specifications.
- c. The mixing equipment shall be capable of producing the quantities of concrete necessary to comply with requirements shown on the plans or in these specifications.
- d. For all mixers, an adequate water supply and an accurate method of measuring the water shall be provided.
- e. Delivery of concrete to the worksite and the discharge from the hauling equipment, agitating, or non-agitating, shall be in accordance with the requirements shown on the plans or in the governing specifications.
- f. Specific requirements for batch plants, mixers and other equipment shall be in accordance with section 03 30 00 Cast-In-Place Concrete.
- g. Continuous Volumetric Mixers. For all miscellaneous concrete placements, a mobile, continuous, volumetric mixer may be used.
 - 1) When approved in writing by the Engineer or when specified for use in other Items, these mixers may be used for other types of concrete construction, including structural concrete, if the number of mixers furnished will supply the amount of concrete required for the particular operation in question.
 - 2) These mixers shall be designed to receive all the concrete ingredients, including admixtures, required by the mix design in a continuous uniform rate and mix them to the required consistency before discharging.
- h. Portland Cement Concrete Plants. The use of ready-mixed concrete from a commercial source will be permitted for all structural concrete provided that the plant, truck mixers, and mixing equipment conform to the requirements of section 03 30 00 Cast-In-Place Concrete. The use of ready-mix plants and ready-mix concrete for concrete pavement shall be in accordance with section 03 30 00 Cast-In-Place Concrete.

2. Mixing

- a. Mixed concrete which does not conform to specification requirements shall not be placed. Mixing shall be in accordance with section 03 30 00 Cast-In-Place Concrete.
- b. Continuous Volumetric Mixers. Mixing shall be in accordance with mixer manufacturer's recommendations unless otherwise revised by the Engineer.
- c. Mixing of concrete by hand methods or by using a small motor driven mixer will be permitted for small placements of approximately two (2) cubic yards or less when authorized by the Engineer. Hand mixed batches shall not exceed a two (2) sack batch in volume. For such placements the mix may be proportioned by approved volumetric methods.

3. Placing, Curing and Finishing

- a. The placing, curing and finishing of concrete, including construction of forms and falsework, curing and finishing, shall be in accordance with section 03 30 00 Cast-In-Place Concrete.

4. Bases shall be cast-in-place concrete. Slab shall be sufficient strength to safely support any H-20 loading.

B. Structure Bases

1. All structures shall be placed on a base of 9" of 1-1/2 sack/c.y. of cement stabilized sand.

C. Precast Structures

1. All precast structures shall conform to the requirements of ASTM C478.

D. Catch Basins

1. Construct catch basins to the sizes and shapes indicated. Use concrete that will attain a 28-day compressive strength of not less than 3,000 psi.
 2. Set cast iron frames and gratings to the elevations indicated.
- E. Grade Rings
1. Grading rings shall be used for all precast structures where required. They shall be a maximum of twelve inches (12") in height, constructed on the top slab on which the frame will be placed. The height of the stack shall be such as is necessary to bring the frame to the proper grade.

3.6 TAP CONNECTIONS

- A. Make connections to existing conduits and underground structure, so that the finished work will conform as nearly as practicable to the requirements specified for new work.
- B. Use commercially manufactured wyes for branch connections. Field cutting into conduit will not be permitted. Spring wyes into existing line and encase the entire wye, plus 6" overlap, with not less than 6" of 3,000 psi 28-day compressive strength concrete.
- C. Branch connections made from the side into existing 12" to 21" conduit shall have a wye sprung into the existing lines, and the entire wye encased with not less than 6" of 3,000 psi 28-day compressive strength concrete.
- D. Take care while making tap connections to prevent concrete or debris from entering the existing conduit or structure. Remove any debris, concrete, or other extraneous material which may accumulate.

3.7 BACKFILLING AND COMPACTION

- A. General: Conduit backfill operations of open-cut trenches closely following laying, jointing and bedding of pipe, and after initial inspection and testing are completed. Comply with the requirements of Section 31 00 00 – Site Earthwork.

3.8 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 1. 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.
 - 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.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 1. Do not enclose, cover, or put into service before inspection and approval.
 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 4. Submit separate report for each test.
 5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Exception: Piping with soil tight joints unless required by authorities having jurisdiction.
 - b. Option: Test plastic piping according to ASTM F1417.
 - c. Option: Test concrete piping according to ASTM C924.

6. Force-Main Storm Drainage Piping: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig.
 - a. Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
 - b. PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.
- C. PVC Piping: Test according to AWWA Leaks and loss in test pressure constitute defects that must be repaired.

3.9 CLEANING

- A. Clean interior of piping of dirt and superfluous materials. Flush with water.

END OF SECTION

SECTION 0334600 – SUB DRAINAGE

PART 1 – GENERAL

1.1 SUMMARY

- A. This section includes subdrainage systems, including piping, fittings, and related components for the drainage of water from under the ground.

1.2 RELATED DOCUMENTS

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

1.3 REFERENCES

- A. ASTM Standards
- B. AASHTO Standards
- C. Local and state regulations

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, and details.
- C. Test Reports: Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with standards of authorities having jurisdiction.
- B. Installer Qualifications: Experienced in performing work of this section.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site in manufacturer's original, unopened containers and packaging.
- B. Store and handle materials to prevent damage and deterioration.

PART 2 – PRODUCTS

2.1 PIPING MATERIALS

- A. Perforated PVC Pipe
- B. Perforated HDPE Pipe
- C. Vitrified Clay Pipe

2.2 FITTINGS AND ACCESSORIES

- A. Pipe Couplings
- B. Cleanouts
- C. Geotextile Filter Fabric

2.3 DRAINAGE MATERIALS

- A. Aggregate Drainage and Filter Material
- B. Asphalt Treated Permeable Material

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Verify that site conditions are suitable for installation.
- B. Notify Engineer of any conditions that may adversely affect installation.

3.2 INSTALLATION

- A. Excavate trenches for subdrainage piping as indicated.
- B. Install piping and components in accordance with manufacturer's instructions and approved submittals.
- C. Ensure proper slope and alignment of piping.
- D. Backfill and compact soil around piping and structures.

3.3 FIELD QUALITY CONTROL

- A. Perform inspections and tests as required.
- B. Repair or replace defective work.

3.4 CLEANING

- A. Clean installed systems and components.
- B. Remove debris and excess materials from site

END OF SECTION

SECTION 334915 - DRAIN ACCESSORIES

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01, GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. Provide all equipment and materials, and do all work necessary to furnish and install the drain accessories, grates, and frames, including aeration pipe grates, area drain grates, and slot drains, as indicated on the Drawings and as specified.

1.3 RELATED WORK

- A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:
1. Section 033001, CAST-IN-PLACE CONCRETE - SITEWORK; Concrete.
 2. Section 329300, PLANTING; Aeration pipe system.
 3. Section 331000, WATER UTILITIES
 4. Section 331001, WATER UTILITIES (Hydrology)
 5. Section 333000, SANITARY SEWERAGE UTILITIES
 6. Section 333001, SANITARY SEWERAGE UTILITIES (Hydrology)
 7. Section 334000, STORM DRAINAGE UTILITIES
 8. Section 334000, STORM SEWER UTILITIES
 9. Section 334600, SUB DRAINAGE

1.4 REFERENCES

- A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.
1. American Society for Testing and Materials (ASTM):

A 36	Structural Steel
A 123	Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.

1.5 SUBMITTALS

- A. Submit manufacturer's product data and installation instructions for specified products herein and on the drawings.

PART 2 PRODUCTS

2.1 SLOT DRAINS

- A. Mini Slot Drain with Removable Grate.

2.2 GRATES

- A. Del Sol Drain Grate.
- B. Miter Drain

2.3 PIPE

- A. Reinforced Concrete Flange Pipe.

2.4 GATES

- A. Mini Sluice Gate.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that site conditions are suitable for installation.
- B. Notify Architect of any conditions that may adversely affect installation.

3.2 INSTALLATION

A. GRATES

- 1. Frames and grates shall be installed at required elevation, and as indicated on the Drawings and in strict accordance with manufacturer's printed instructions.

B. SLOT DRAIN

- 1. Frame and grate shall be installed at required elevation, and as indicated on the Drawings and in strict accordance with manufacturer's printed instructions.

3.3 CLEANING

- A. Clean installed systems and components.
- B. Remove debris and excess materials from site

END OF SECTION